AIDE-MÉMOIRE

TO

THE MILITARY SCIENCES.

FRAMED FROM

CONTRIBUTIONS OF OFFICERS

OF

THE DIFFERENT SERVICES,

AND EDITED BY

A COMMITTEE OF THE CORPS OF ROYAL ENGINEERS.

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PREFACE

TO

THE SECOND EDITION OF THE FIRST VOLUME

OF

THE AIDE-MÉMOIRE.

THE 'Aide-Mémoire to the Military Sciences' was brought to a conclusion in December, 1851, and a Second Edition of the early Parts having been required, the present Volume — after a careful revision of many of the subjects by their several Contributors — is now submitted to the Officers of the respective Services. A few observations are therefore necessary, for the purpose of explaining any errors or deficiencies which may have occurred in the progress of the Work.

In our first Part we explained that the 'Aide-Mémoire' was intended only as an abstract of principles as well as of details useful to all Branches of Her Majesty's and the East India Company's Forces, although with more especial reference to the wants of our own Corps: hence some of the Collateral Sciences

are given more copiously than usual in Military Works; and if any deficiencies should appear, we must beg our brother Officers to compare the list of subjects proposed in our Circular of 1843 with the Index at the end of the third volume, and then judge how few there are.

The object of the Work, as explained in that Circular, was to supply, as far as practicable, the many and common wants of Officers in the Field, in the Colonies, and remote Stations, where books of reference are seldom to be found, useful to the Engineer, Artillery, and Line Officers, in their military capacity, as well as to the Governors and Commandants of Posts in their civil capacity, and instructive to all the junior branches of the Service in their leisure hours.

The 'Aide-Mémoire' was not intended to be a Military Dictionary or Encyclopædia, or even a Manual, but as a reminder and reference—for which short Essays and Tables are given—to the Military and Collateral Sciences previously studied. The alphabetical arrangement has been followed for convenience, although not implicitly, from unavoidable difficulties; and consequently, where there is an apparent omission, the Index has in some cases to be consulted.

Since the publication commenced, the regulations for admission to the Army have made it indispensably necessary that the Sciences connected with its Duties should be more closely studied, and thus the Work is rendered the more valuable as a Book of Reference to Officers of the Line.

The 'Aide-Mémoire' will be found to embrace most contingencies required, not of an elementary nature, in

Sapping and Mining;

Engineering Duties in the { Field; Attack and Defence; Garrison;

Pontooning and Passages of Rivers;

Principles of the Duties of the { Cavalry, Artillery, Infantry, Staff } Officers,

including the Tactics of the Three Arms, each of which, before the publication of the 'Aide-Mémoire,' required a separate work for reference: these wants, with the valuable assistance of Officers of the various Services, the Editors have endeavoured to supply.

Captain Grivet, of the Corps du Génie, in the Preface to his 'Aide-Mémoire,' lately published, explains that he had undertaken the work from the impracticability of inducing Officers to unite their labours for such an object: hence Captain Grivet's publication has a want of originality which the 'Aide-Mémoire to the Military Sciences' possesses by the united efforts of our Corps and other branches of the Army; and when these have been wanting, the Editors have consulted the best authorities to supply those omissions, as will be seen at the end of the third volume in the list of Contributors.

Considering the multifarious avocations common to every part of the British Army, and more especially those of the Engineer Corps, the labour has been long and arduous, occupying a period of seven years, much time having been necessarily required to collect

such a mass of information from remote and distant Stations of the Empire.

During this long space of time some changes have naturally occurred in the Equipment of our Services, and consequently rendered it necessary to revise the Tables and Drawings contained in this Second Edition of the first volume.

G. G. LEWIS, Major-General, R. E.
H. D. JONES, Colonel, R. E.
T. A. LARCOM, Major, R. E.
JOHN WILLIAMS, Captain, R. E.

Woolwich, February 1, 1853.

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† These Plates to be placed opposite page 25 in the second volume.

AIDE-MÉMOIRE.

SKETCH OF THE SCIENCE AND ART OF WAR.

BY LIEUT.-COLONEL C. HAMILTON SMITH.

"Hoc illud est præcipue in cognitione rerum salubre ac frugiferum, omnis exempli documenta in illustri posita monumento intueri: inde tibi tuæque reipublicæ, quod imitere, capias: inde fœdum inceptu, fœdum exitu, quod vites."—T. Livii *Præfatio.*

Introductory Remarks.

War, theoretically studied, is found to depend upon demonstrable principles which make it a science, and the adaptation of the principles to practice converts that science into an art. But, although at first sight the theory is sufficiently clear, the great variety of circumstances which must be taken into consideration, and the momentary alterations these present, are causes that of all arts it is the most complicated and uncertain in the application. Hence, to write on the subject authoritatively would require an intellect capable of fully embracing every branch of the science, as well as practical experience in command. No such claims can be advanced for the following pages; the consideration which they may deserve reposing solely on principles laid down in general by established reputations, such as those of Frederick the Great, Lloyd, Tempelhoff, the Archduke Charles, Jomini, Bülow, Klausewitz, and others; or, as regards the maxims relating to British operations, derived from the above in the form of more particular adaptations, or historically substantiated by events. But, writing less to inculcate than to remind readers familiar with arms, few proofs and short summaries have been preferred to lengthened unnecessary discussions, for which, besides, there was not space in the work. Recourse, however, has been had chiefly to the article 'War,' published in the Supplement of the sixth edition of the 'Encyclopædia Britannica,' and to the 'Précis de l'Art de la Guerre' by General Jomini: the latter may still be regarded as the best on the science, although the author, when adverting to questions where the British army and its commanders are concerned, is generally misinformed, uncandid, and biassed: he evinces a feeling still more bitter against the Prussians, and even against his countryman General Warnery; all the more to be regretted, as this want of impartiality detracts from his authority as a scientific soldier.

It should be observed, moreover, that his maxims, data, and inferential reasoning always emanate from a point of view where armies of 150,000 men or more contend with similar forces on the surface of Europe for the destruction or safety of the greatest empires. These are not ordinary wars, and although the ruling principles must remain the same in all, British forces acting on the Continent, even when they constitute the main strength of an army, still co-operate with allies and with hired auxiliaries, which cause essential modifications in the principles; and the fundamental thought which rules the whole system of its hostility is rarely other than offensively

defensive; directing the blows not to the destruction of the enemy, but to the deprivation of his colonial and commercial resources, and thus obtaining an honourable peace by the restoration of the balance of power in Europe. In this view the sketch here offered is reduced to an abstract form, with a few examples where the questions turn upon great continental operations, in order to afford somewhat more space for those which refer directly to insular expeditions, such as constitute the far greater portion of the military operations of the British army. The experience of preceding wars shews that these undertakings are likewise amenable to general principles completely in harmony with the general maxims; requiring no other proofs than allusion to past events, most of which are known to all studious Officers, and therefore are in no want of circumstantial narratives: yet as they have not been subject to much public discussion by competent parties, and on some points valid objections exist against received conclusions, cases are pointed out where armies in alliance with Great Britain might have been saved and positions occupied which would have arrested the progress of the common enemy, if more enlarged views had swayed their resolutions, and more reliance had been placed upon the power that is mistress of the sea. The mere indication of these facts has been deemed sufficient to those, who, understanding war, feel a single word will convey all the other ideas that emanate from them. Where the notices are somewhat more diffuse, they relate to such British operations as seem never to have been investigated upon the principles of military science. It is true that assent and dissent to military reasoning depend often not so much upon the absolute truth of the principles as on the manner of considering them in different armies: the geographical position and structure of the Austrian and Prussian territories influence the opinions of their schools as much as those of Russia and France under other conditions produce the same effect; and the British, totally different by institutions and insular location, is widely distinct from them all. The value of the aphorisms is therefore narrowed to where they are alike admissible in all, and their importance diminishes as they become more influenced by circumstances.

A British military writer may view the questions involved in the term 'great operations' ('grande tactique' of the French) either as they are based on the general principles of the science, in the light they are viewed by continental strategists, or, narrowing the subject, take it up on the insular position of the empire and the local conditions which result from it. For the one leads to operations of immense armies and objects which menace the very existence of states, while the other contemplates principally defensive measures at home, assistance to an ally abroad, and offensive expeditions to distant countries; mainly depending on the superiority of the Royal Navy, and with land forces in no case amounting to more than 50,000 national troops. Hence, on the continent of Europe, the British land forces seldom form an army, or the majority of an army, though generally they constitute the sinew, or main element of strength in a combined force. The views, moreover, which the Government entertain being almost without exception confined to the conquest or recovery of a province in aid of an ally more than for its own aggrandisement,—or, while aiming at the destruction of an enemy's commercial resources, they are directed towards the trading ports or naval stations of an opponent,—the maxims which inculcate striking at the vital power of an enemy through his capital are but little appreciated or applauded. These views are a necessary result of the national military system; for Great Britain, with her immense colonies and popular institutions, on the restoration of peace, always reduces the whole armed establishment to a bare sufficiency for garrisons and recruiting; and on the recurrence of hostility with a great power, such as France, is compelled to reinforce her colonial possessions with nearly the whole of the old and well-

trained regiments; trusting to new levies, and in part to inexperienced subalterns, for the construction of an army for the field. Meantime, the enemy with a great disposable force on land, but inferior at sea, calculates on the restitution or on compensation for the loss of his colonies by assailing a neighbour,—indifferent whether he be an ally of his opponent or a neutral, because the act of invasion will reduce him to be such; possession will give the rights of conquest; and, perhaps, while another continental system is in agitation, full restitution of the lost colonies may be held out as the price of evacuating the unoffending state, and credit demanded for justice and moderation. But if another great continental power is awakened, and takes up arms, it must be supplied with subsidies; it meets with discomfiture,—the war is protracted, and at length a corps more or less strong from England joins the ally, and is mainly instrumental in the restoration of affairs, until peace resumes her sway, and bloodshed, debt, and glory is the unsatisfactory reward.

Since the wars of the French revolution, the altered condition of the political preponderance of the great military monarchies and the increased influence of public opinion may be expected to affect the question of hiring foreign troops for British service or taking allies into pay; and the application of steam to maritime war, which will affect more particularly the tranquillity of the coasts, the security of Ireland and of the Channel islands, are novel questions not to be overlooked in cases of future serious hostilities.*

Although some of these are problems solely depending upon the Cabinet for solution, Military Officers who may and ought to be consulted should not be unprepared with opinions duly formed; and from the advanced condition of the science of war on the Continent, together with a consideration of the characters who usually compose foreign ministries, British statesmen cannot themselves remain indifferent to the knowledge of at least the fundamental principles which from henceforth all parties are to look to for security at home and success abroad. For Great Britain and Ireland the defensive question alone requires not simply an accidental or momentary attention directed to a solitary point or instant of alarm, but a well-digested system embracing the whole.

These remarks are submitted as mere instances of the fundamental questions whereon the basis of all military reasoning must repose; but war is a condition of existence so absorbent, so vast, so various and difficult, that viewed as a science it can scarcely be handled but in part, and then it still becomes so voluminous that we must be contented in this Paper to notice only its more important considerations, and give definite notions of terms and their applications to the best of our abilities and the extent our space will allow.

By Military policy of a state may be understood the habitual views of a Government, regarding its ambition or interests externally directed towards objects to be attained by force, or internally to be guarded by defensive means.

The *Military system of a state* denotes the nature and composition of the forces by sea and land; the militia and reserves; their organization; laws, pay, recruiting, clothing, discipline, instruction, promotion, rewards and punishments; fortifications, fleets, ordnance, equipments, and all other elements required in war.

Military invasion and occupation may occur without hostility, at the desire or by connivance of an ally or a neutral power, claiming the protection or assistance of a

* Since these ideas were first written on the article 'War,' and repeated above, the pamphlet of the Prince de Joinville shews what is the view on the subject in France.

friendly force; or it may be without hostile events, such as a siege or a battle, and thus is not a positive state of *War*.

War is constituted by the actual employment of force, for the purpose of obtaining by arms that which is withheld by similar means: it may be viewed under a variety of modifications.

Thus, war is offensive or defensive; it has for its object the total subversion of the enemy's power, or is confined to reducing it within given bounds. War may be undertaken as a principal, or only as an ally; it then may become one of intervention, or one of opportunity; that is, where a power at first neutral takes up the cause of one party, and thereby produces a preponderance with a benefit to all the allies, or to itself in particular, for which it has been waiting a fit conjunction of political affairs. In all these cases the mode of enforcing the first great principle of war requires corresponding modifications, so as to adapt the means to the end proposed.

There are wars of opinion and religious wars, for which scarcely any rules can be offered, excepting patience, the exercise of humanity, and rectification of real grievances; but these belong not to military science, and do not therefore concern our present purpose.

War, theoretically viewed, should be waged, according to Jomini, in conformity with one great fundamental maxim, which, rightly applied, renders all combinations appropriate, and, when misapplied, faulty. This governing principle is "*to effect with the greatest mass of forces a combined operation upon the decisive point.*" This decisive point in war, also termed "*the primitive objective point,*" is that wherein resides the principle of the hostile strength, or what has been called the vitality of the Government. To dislocate this power in the shortest and most effectual manner is clearly the fundamental principle for the assailant; and as clearly to avert it by breaking his measures, must be the object of the defendant. But as the aim of belligerents is commonly of a much less decisive nature, the principle remains then most applicable, but still the same, to minor objects.

A British expedition necessarily acts offensively; the Commander, fully instructed in the nature of the operations that are intrusted to him, and familiar with the theatre of war, so far as the best maps, &c., can supply information, has already, in concert with the Government, selected the point intended to form the basis of his operations; which, nevertheless, may greatly vary, from political and nautical, as well as considerations of allied co-operation. The choice of a basis always, either on a hostile or a friendly frontier, determines the sphere, or what is termed the ZONE OF OPERATIONS: it is from thence the Commander of the Forces selects the objective point which he is to aim at, and the line of operations leading to it; and that line may be either temporary or definitive.

Continental armies operate precisely in the same manner, but with more certain facility, because the basis of their operations is on their own territory, unopposed by distance, sea, and winds, for progress or retreat. Their artillery trains, commissariat, and baggage have their equipments; their cavalry is mounted, and subsistence secure; while a force disembarked from sea is without horses, and always obliged to sacrifice invaluable time before it can move, even in a friendly country.

The army marching upon its line of operations is in possession of a front of operations, or a strategical front, in rear of which it is advisable to fix a point of *appui*, or support; that is, a fortress or locality on the line in question, to resort to in case of necessity. The momentary positions which the corps of the army may occupy on the front of operations, or on the line of defence, are strategical positions. When the army is within reach of the first objective point, or when the enemy commences

to oppose its progress, the Commander-in-Chief either attacks him or manœuvres to compel him to retreat. In this view he may select one or two strategical manœuvring lines of a temporary nature, and as such they may deviate to some distance from the intermediate posts, from which they are perfectly distinct. To connect the front of operations with the basis, a staple line, &c., will be formed, to subsist parties and convoys at certain places in their daily marches from and to the army, extending it by degrees as the forces proceed further; and more considerable dépôts of provisions will be made on the commissariat lines to subsist the main body. If the line of operations deepens in length from its basis, and hostile corps threaten to interrupt it, then there will be the option either of attacking and expelling the enemy's detachments, or of pursuing the main object against the army, without regard to these secondary corps. But if it is determined to keep it in check by means of a detachment posted in observation, a double front is produced, and great detachments always cripple the army.

When the objective point is neared, and the enemy resolutely maintains his ground, a battle must be the consequence: should the result be indecisive, a second attack must be made; and, when victorious, the ensuing measures should extend beyond the objective point first aimed at, and endeavour to pass beyond it by fixing upon a second ulterior object. If the capture of an important fortress is the aim, while the siege is undertaken, the coercing army should proceed to drive the enemy far off; or, if it be not sufficiently strong after the besieging corps is formed to push forward, a strategical position should be selected to cover the siege, such as the French, under Bonaparte, adopted in 1796 to cover the siege of Mantua, or it should operate as Marlborough did during the siege of Lisle.

But where there is no siege, or the army is in force sufficient to carry on operations to a second point, it will become requisite to form a point of *appui*, and to construct an Eventual Basis, by occupying one or more towns sufficiently fortified to be safe from insult; or a small strategical reserve should be formed to cover the rear, to protect convoys and the greater dépôts by means of field-works. Should rivers of considerable breadth intervene, *têtes de pont* should be raised to cover them; and if the bridges occur at walled towns, some additional works should be constructed to protect them. These are requisite both to strengthen these posts and add to the solidity of the Eventual Basis where the strategical reserve may be posted.

But should a battle be lost, retreat must ensue towards the basis of operations, in order to collect reinforcements and detachments, replace the deficient materials, and reorganize the elements of combat in fortified towns or intrenched camps, so as to arrest the enemy's progress or compel him to divide his forces.

When winter approaches, the army is placed in cantonments, unless the operations are continued by one of the opposing armies; namely, that which having obtained a decided superiority, finds no insuperable obstacles on the hostile line of defence, and is therefore resolved to make the most of its ascendancy: then a winter campaign is produced, always equally distressing to both armies; but demanding no particular dispositions excepting redoubled activity in the enterprises, in order to arrive the sooner at the desired results.

Such is an abstract view of War as a Theory, and is sufficient to shew the different combinations which the operations produce. They are divisible into three branches.

1st Branch. STRATEGICS.

I. Strategics: a term to which it has been vainly endeavoured to affix a strict definition from the times of Folard, Derelinque in MSS.,* Bülow, and Von Gross,

* Derelinque, 'Tactique des Batailles de l'Impulsion,' &c. Manuscript, four vols. folio, with an immense number of plans, in my possession.—C. H. S.

to Klausewitz, Dufour, and Jomini, whose earlier works and last Précis give the most comprehensive as well as the most satisfactory definition; although a dialectician might hint that a distinction might be pointed out between Strategics and Strategy, or *Strategique* and Strategie; but no inconvenience seems to have arisen from the promiscuous use of both. Jomini's definition embraces under the word 'Strategie'—

1. The definition of the theatre of war, and the different combinations it may offer.
2. The choice and establishment of the Fixed Basis, and Zone of Operations.
3. The determination of the Objective Point to be attained, whether it be offensive or defensive.
4. The Determination of the Decisive Points of the theatre of war.
5. The Fronts of Operations and Defensive Lines.
6. Selection of the best Lines of Operations leading from the base to the objective point, or to the front of operations.
7. Selection of the best Strategical Lines for a given operation; the different manœuvres for embracing these lines in all their combinations.
8. The Basis of Eventual Operations, and Strategical Reserves.
9. The manœuvring marches of the army.
10. The magazines considered in relation to the marches of the army.
11. Fortresses considered as strategical means; as places of refuge for an army; as obstacles in the way, or as requiring sieges and covering armies.
12. Intrenched camps, têtes de pont, &c.
13. Diversions and great detachments.

In the several objects enumerated, those which enter chiefly in the sketch or general plan of a campaign, regarded as cabinet and head-quarter questions, have been named. The art of making war, upon a map, might be appropriately distinguished by the comprehensive designation of STRATEGICS; while all those which are strategical in their direction, and tactical in the execution, such as landings, march manœuvres, passage of rivers, retreats, winter-quarters, ambuscades, and convoys, might take the denomination of STRATEGY, so long as they are executed without the presence of an enemy prepared for resistance; for then they become Tactics.

The first therefore (Strategics) ***is the art of embracing the lines of operations in the most advantageous manner;*** the second (Strategy), ***the art of moving forces in the most efficient manner upon the primitive or accidental lines of operations.***

2nd Branch. TACTICS.

II. The second branch is denominated Tactics, and consists of the manœuvres of an army for action and in action, together with the several formations of troops for attack and defence; in both cases requiring simultaneous combination on the most important points of a field of battle, or the directing the mass of offensive elements on the weakest part of a position or fortress (as in sieges), offensively or defensively.

Thus Grand Tactics embrace more especially—

1. The choice of positions and defensive lines of battle.
2. Offensive defence in action.
3. Different orders of battle, or great manœuvres for attacking an hostile line.
4. Meeting an enemy's army on the march, or unforeseen battle.
5. Surprise of armies in the field, not in winter-quarters.
6. Dispositions for an Attack.
7. The Attack of positions and intrenched camps.
8. Coups de main; Escalades.

British forces, generally less numerous, might join to the above—

9. Debarcations in the presence of an enemy.
10. Re-embarcations in the presence of an enemy.
11. Actions with the advanced or rear guards.

But conflicts on the outposts, convoys, foragings, and war detachments, belong to what is termed *Petite Guerre.*

3rd Branch. LOGISTICS.

III. To these Jomini adds La Logistique, or the practical art of moving troops, the details of marches and formations, the location of encampments and cantonments; in short, the execution of the combinations of Strategy and Tactics. These three branches are more or less interwoven, and, of course, are further connected with Elementary Tactics, the basis of all military order and system.

STRATEGICS. Fundamental Maxim of War.

The definition already given, namely, *effecting with the greatest mass of forces a combined operation upon the decisive point*, and modifications thereof, are good when they are in conformity with the following maxims:

1. To convey by strategical combinations the mass of forces successively on the decisive points of a theatre of war; and as much as possible, on the communications of the enemy without exposing its own.
2. To manœuvre so as to impel this mass upon fractions of the hostile army.
3. On the day of battle, to direct by tactical means the same superior mass upon the decisive point of the field of action, or on that part of the enemy's line which it is of most importance to crush.
4. To produce the masses not passively on the decisive point, but in active operation, effecting the object aimed at by simultaneous effort.

An objection has been raised to these maxims, upon the plea that the art consisted precisely in clearly distinguishing decisive points. Their definition will be given in the sequel, and the studious soldier who meditates upon the contents, will rarely mistake them; for a theatre of operations never offers more than three zones, one on the right, another on the left, and a third in the centre; so also each zone, each front of operations, each strategical position and line of defence, like each tactical line of battle, has never more than these same subdivisions, or two extremities of a centre. Of these, one only can be best for reaching the mark aimed at; a second will be less advisable; and a third actually vicious. Therefore, combining the enemy's positions with the geographical points, with consideration of the zone of operations, and with the projects to be effected, all questions of strategical movement and tactical manœuvre resolve themselves into the knowledge whether the operation should be carried on by the right, the left, or by the centre directly to the front,—surely not a difficult problem. Yet, though the whole art of war does not consist solely in the choice of a proper direction for the mass of forces, in that, nevertheless, resides the fundamental maxim of strategics; for there still remains the necessary talent to execute, the knowledge, energy, and coup d'œil for carrying out what proper combinations have prepared. The study of all past wars, ancient and modern, the systems of war of Frederick the Great, of the French Revolution, of Napoleon, and, finally, of the Duke of Wellington, will all be found to have derived their success and glory by conducting the armies in harmony with these principles; and the loss of battles, failures in campaigns and entire wars, will be seen to originate in the non-observance of them, either through the prejudices raised by ignorance or routine, political interference, or unavoidable geographical causes.

Plan of a Campaign.

The plan of a campaign depends upon six essential considerations. 1. The political situation of both parties. 2. The situation of the moment. 3. The relative force and military means. 4. The location and distribution of the armies. 5. The natural line of operations. 6. The most advantageous line of operations. It is not required on this occasion to be carefully balancing the exact amount of the relative means of war between the parties, but to admit them only as far as they are important. Territorial and Manœuvring Lines of Operations are the principal objects; and though they are subject to many accessory considerations, the rules of the art must, nevertheless, form their basis. Originality and great boldness are not incompatible with their application; such, for instance, as the plan which in 1800 Napoleon and Moreau carried into effect,—"moving on the flanks of the Swiss mountains on two internal lines; the latter, upon the Austrian external line in Germany, and the former, similarly, but still more originally, upon the flank and rear of Melas, in Lombardy. Never was the great principle above noticed exemplified with more originality or daring; no operations were ever more rich in great and decisive combinations, or more prudent and cautious in the execution; since while they menaced and effected the enemy's ruin, neither, in case of reverse, would sacrifice more than perhaps the rear guard."—*Jomini.*

In this place it may be useful to fix, by definitions, several terms, upon the comprehension of which the understanding of most important military reasoning depends.

By a *Base* (or *Basis*) of Operations is meant a frontier,—the course of a river,—a coast,—a range of mountains or fortresses,—or any topographical or military extent of country, upon the imaginary line of which the corps of an army assemble: offensively,—to take their departure from thence into the enemy's country, and towards which, in case of failure, it is intended to retreat: defensively,—to counteract all the measures which an invading force may attempt.

Lines of Operation are divided into *Territorial* and *Manœuvring Lines.* By *territorial lines* are understood those which nature or art has traced for the defence or invasion of states. Frontiers covered by fortresses, or defended by nature with chains of mountains, great rivers or other obstacles, are of this nature.

Manœuvring Lines are the movements of the General to traverse the territorial lines offensively or cover them defensively. Both these lines are intimately connected. In offensive war the line is an imaginary perpendicular upon the base, along which an army operates against the enemy. In defensive war it is often the same, but still oftener parallel to the territorial line.

A Line of Communication is either the same as that of operation, or any other by which the army supplies and communicates with the Base.

Examples will make the definitions more intelligible: Austria and France have three great lines of operations against each other; by Italy on the south, Switzerland and the Tyrol in the centre, and by Germany on the north. But politically and geographically considered, these are now all closed, because the states of Baden and Wurtemberg interpose between them in Germany; Switzerland is independent in the centre; and the kingdom of Sardinia closes up Italy. Between Prussia and Austria there are similarly three lines, through Moravia, Lusatia, and Saxony.

The *Theatre of Operations* embraces the whole surface of the country which an army, or armies in co-operation, may have to invade or to defend. If a single army has a prescribed end in view, its strategical field extends no further; but, if the combinations of two or more armies are in concert, and directed, beyond the first proceedings, to arrive at an ulterior object in conjunction, then each army operates only upon a zone of the field. Thus a *Zone of Operations* contains the particular

lines which an army acting in concert with others has to traverse to an ulterior object; and a *strategical field* or chess table (*échiquier général*) comprehends the whole theatre of war from the single or double basis of one or more armies, to the ultimate object, usually the enemy's capital. Hence, two belligerents have each, 1, a fixed base of operations; 2, an objective point; 3, fronts of operations and lines of defence; 4, zones and lines of operation; 5, strategical lines and lines of communication; 6, natural and artificial obstacles to surmount or to oppose to the enemy; 7, important strategical geographical points to occupy offensively, or cover defensively; 8, accidental and intermediate bases of operations between the objective aim and the fixed base; 9, points of refuge in case of a reverse.

OFFENSIVE OPERATIONS. An army which commences offensive operations where no sea intervenes, takes the lead in all the movements, and those opposed to it are necessarily subordinate to them. If, therefore, it occupies with a corps each of the great avenues leading to the enemy, he will be kept in suspense, unless his own forces are sufficient to anticipate the opponents by making the first move, and to assume the offensive defensive. Therefore,

1. When an army invades or acts offensively, it takes the lead (*l'initiative*) in the movements.

2. This advantage precludes the necessity of marching in mass, unless the enemy is concentrated and at hand.

3. The general direction can be only upon the centre, one of the extremities, or the rear of the hostile line. An extremity is usually the most eligible, because nearer to the hostile rear; on the centre it is safe only when the opponent's line is still scattered.

4. In this case Jomini recommends the greater number of corps to advance upon one of the isolated parts, with a view to surround it, while the remainder occupy a central point to keep the rest of the hostile army in check.

5. When the principal mass of these corps is directed into the rear of an enemy, by passing one of the extremities of his line, one corps should remain posted upon that extremity, in order to keep open the line of communications, while the opponent is cut off from his. This corps serves likewise to attack his flank and prevent his withdrawing from a faulty position by a secret movement.

Both these last rules evidently apply only where the assailant has a considerable superiority; for in cases where the forces are nearly balanced, he that turns an enemy's flank is exposed to the same manœuvre; and a single corps left to mask the extremity of an hostile line, is less in measure to be reinforced than the enemy, and therefore liable to be defeated, and the whole assailing manœuvre exposed to be enclosed, unless topographical circumstances are more than ordinarily favourable. Thus the celebrated march over the Alps, by means of which Bonaparte, in 1800, turned the whole line of operations of Melas in Italy, would have been counterchecked, had there not been a misunderstanding among the Allies. Sir Charles Stuart, with 10,000 British, was before Genoa, and offered to take charge of the position; but the Austrians, eager to grasp at the possession of all Lombardy and the Genoese territory, declined the proposal, in their turn requesting the British to disembark and join their army, for an Austrian, not an allied purpose. Jomini, it is true, aware of the danger such operations incur, elsewhere confines them to no greater length than two or three marches, and does not admit the corps to be separated from each other, further than the outposts are from their corps.

In these rules none occur directly calculated for the plan of a campaign operating from a coast or an insular basis. Great Britain in continental warfare has three fronts or fixed basal lines, by which the army under cover of the fleet may proceed to

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act offensively on a foreign coast: the Eastern, from Yarmouth to the Downs: the Central, from the Downs and Portsmouth to Southampton: and the right or Western, from Southampton to Plymouth and Cork. There are, however, many difficulties in the application of masses upon the secondary base abroad, especially if that base must be obtained by force on an hostile coast, because the line of communication from the sea-ports at the fixed base whence the army has departed to the point of debarcation is lengthened, and, by reason of the intervention of the elements, liable to be broken: still the examples of the landing at Aboukir Bay, Copenhagen, the Mondego in Portugal, the Helder and Walcheren, all in the face of the enemy, prove the practicability even when opposed on the spot. The point of debarcation is then the Eventual Basis; and unless a friendly fortress, or one that can be compelled to submit by summary means, or a naturally advantageous position can be occupied or immediately forced, the difficulties are almost insurmountable. It is, again, difficult to despatch a large force in one fleet, and to keep it together, and dangerous to allow great intervals; the elements affect the time, connection, and order of convoys: an independent and separate service (the navy) influences the primary organization: a distinct etiquette may intervene in the moment of execution: debarcation, not so much of the troops, as of their resources, artillery, horses, provisions, &c., require much of invaluable time, and a change of wind may defeat or endanger the whole measure. While a great Captain is at the head of the Army and of the Cabinet, only that which human prudence cannot control will be left to chance; but there have been periods when military experience was not sufficiently appreciated in war measures; and civilians directed them without being even aware that war is an exceedingly complicated science, and that one great error in the plan of operations is sure to end in failure. Yet more than two centuries ago Sir Walter Raleigh said, "the wisdom of princes and of states is best determined in their enterprises."

From the difficulties above stated, a practice has arisen of fitting out expeditions, not sufficiently formidable, with a view of ascertaining the practicability of a measure, but which by that very system is often rendered abortive; for a first landing having been effected, the enemy's attention is no longer divided; he collects his means of defence, while the second convoy is expected, and the delay is decisive of the event. Yet, if in any military operation the effect of masses simultaneously employed be of consequence, it is in those which commence on the sea shore; for the troops have not only to debark and act offensively, but also to construct their means of security and retreat in case of disaster. If we examine the primary operations of this class from the wars of King William to the present period, we shall find, that with the exception of such as were favoured by circumstances, the success or failure was dependent upon one or more of the following maxims, especially as applied to continental expeditions.

1. When an army is embarked to make a descent upon an enemy's coast with the object of penetrating into the country, a point of debarcation should be selected where the enemy possesses no local means of arresting the descent and preventing the landing of a sufficient supply of those means which are indispensable for action and for progress. If therefore a defensible peninsula can be selected, or better, a fortified town accessible for the cannon of the covering squadron, to compel it into an immediate submission, a footing will be gained to form the first point of the Eventual Basis of operations. Still the consideration whether such a point is favourable to the ulterior objects of the expedition should be kept in view. A secure anchorage is necessary for some time either on the spot or in the immediate vicinity, and within the sphere of action of the land force.

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2. If the expedition be intended to operate only on the coast with momentary objects, proximity to the objective point should be combined with a locality convenient for re-embarcation. Armed steamers and gun-boats will, in general, secure this object within estuaries, in defiance of a superior enemy on shore. But small expeditions are fit only to distract the enemy's attention, and for that object demonstrations without landing will generally answer all the purposes of descents. Raleigh justly says, "*All petty attempts are more profitable to the invaded than the invader.*"

3. An expedition intended to operate ulteriorly, should be from the first superior to the probable immediate force of the enemy, so that the landing be effected with more decisive success, and the ulterior movements may proceed without delay.

4. No combinations of invasion should be made to depend on the co-operation of corps expected from distant or opposite quarters. It is important to embark them en masse, or, commencing at the more distant part, collect them in passing, or form a rendezvous at an intermediate point, so as to proceed at last with the whole in connection. For instance, if the season is favourable, a rendezvous off Cork, Bantry Bay, or some island in the Bay of Biscay, when the expedition is really intended for the north or west coast of Spain or Gibraltar, or for the Mediterranean, would tend to keep the enemy in suspense.

5. After the landing is securely effected with the view of striking a blow in the interior, it is best to waste no time in besieging any place not directly in the line of operations: let them be masked by a corps on shore, and blockaded by the fleet; or if the line-of-battle ships can attack a front of defence, they will reduce the fortress in a few hours.

6. In the plan of an expedition no combination should be admitted including or depending upon two or more lines of operation from separate bases. Armies transported by sea are, from that circumstance, not numerous: division renders them still weaker, and if one corps is checked, the other must retreat also. It is exposing two exterior lines to one internal line.

7. In colonial and insular expeditions it is only necessary to combine means in proportion to the strength of the objective point, and with attention to the season, climate, monsoon, or trade-winds.

8. An army withdrawing from a territory through another which it is resolved should be kept in subjection or mastered, the occupation should take place at the moment when the greatest mass of forces is passing through or near the most important points.

9. When negociating at the head of an armed force with the chance of resistance, it is important that all the corps be collected to give weight to the demands, and to act instantly when hostilities become inevitable, rather than call for reinforcements when they are begun, and risk to be defeated from absolute inferiority.

10. In offensive extra European wars it is particularly false economy to employ insufficient means against an enemy, to undervalue his resistance, or to aim at indecisive objects. If such measures cause no absolute failure, they at least prolong the contest, occasion the waste of life and expense, are a source of greater risk than should be incurred, and of less advantage in negociation.*

* The Saxon Colonel Von Gross (Kriegs Geschichte der Jahre 1792 bis 1808) enumerates on the subject of our marine expeditions several others to be requisite, such as:—1. Seasonable period; 2. Thorough knowledge of the country; 3. Intelligence in the country; 4. Dominion of the sea;

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None of these rules should be so modified as to be opposed to the great maxims of war; nor should operations of any kind be undertaken without regard to the class of troops to be employed.

As examples of the importance of the first rule, may be quoted the landing of the emigrants at Quiberon; for if they had not been betrayed by their own men, they still, through supineness, were blocked in and unable to débouche in the face of the enemy. Again, the Helder expedition in 1799, though victorious in two battles, could not advance to the objective point, because through former misdirection of the forces, the enemy, retiring to the narrows of the Haerlemmer Meer, had a position which could not be forced nor turned. On the other hand, at Aboukir in Egypt, a peninsula, the landing was on a central point, which placed the enemy's defensive measures on two external lines, one covering Alexandria and the other Rosetta and Cairo: thus divided, although numerically the strongest, he was inferior on both lines, and ultimately forced to surrender. The landing at the point of Mondego, in Portugal, though again divided by a subsequent force coming on shore at Peniche, shewed a still more advantageous selection, for the enemy could not oppose it, nor attack Sir Arthur Wellesley, until all his troops and cannon were already moving offensively: the debarcation cut off the north of Portugal from Lisbon, and the hostile army from its line of communication with France; and if the re-inforcement under Sir John Moore, that came after the battle of Vimiera, had been sent from the first with the army, Junot must have surrendered at discretion, instead of obtaining a capitulation that sent his army back to France.

In the second maxim, the causes are pointed out which afforded in 1758 a secure retreat from the landing at Cherbourg, although no regular precautions insured the measure; and those which produced the disaster at St. Cast, notwithstanding all the care General Bligh applied to the re-embarcation. The expedition to Ostend had the same defects, and produced the same results; but, with moderate weather, the naval armaments, as now organized, render such operations much more secure.

Inattention to the third rule had preponderating influence at the Helder. The first division on shore was paralyzed behind the defences on the Zyp until the main body arrived. Meantime the enemy, now certain of the point threatened, collected his means, and, as before stated, rendered victories so unavailing that re-embarcation was purchased by heavy sacrifice.

The expedition to the Helder furnishes the proofs of the fourth maxim. Had the two British corps and the Russian been combined to act simultaneously en masse from the beginning, no effectual resistance could have been made against them; but easterly winds were to convey the Russians westward, and westerly the British eastward, though both were destined for the same point at the same moment. So again, the Egyptian expedition was to be sustained by a corps from India and another from the Cape. At Copenhagen the two British corps united in proper time, because that which was anteriorly in the Baltic lay waiting in transports at Rugen; but the successive divisions sent to the River Plate served only to be successively defeated.

The fifth maxim is exemplified in the Walcheren expedition.

The sixth maxim is obvious. Sir John Moore's expedition was on the coast of Portugal when the battle of Vimiera was fought, where it should have been present, for a corps on board ship cannot aid one on shore, and, if that is defeated, the other must retire also. In the next campaign, Sir John, by several lines from Portugal, and Sir David Baird from Corunna, moved by two zones of operations, with a view

5. Vicinity of the points of debarcation; and ending with the recommendation of measures to keep up and increase the good-will of the people.

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For offensive operations against hostile insular colonies, the foregoing remarks are already sufficient; but as in general they imply not only landing but a siege, it is of the utmost importance that the most efficient means be employed for certain and rapid success, not only in the numbers and quality of the *materiel*, but in a body of Engineers and Artillery aided by Sappers and Miners; for by their means fortifications are reduced in the most speedy and least sanguinary manner; the system of destruction produced by shells and rockets may in a great measure be dispensed with, or at least confined to military defences; and delay is ever the cause of failure.

The two last maxims are of themselves sufficiently obvious, although disregard to them has been often exemplified; but some further illustrations of the principal rules of strategics may be necessary. We find, for example, in the wars of America, Lord Amherst operating by the line of Lake Champlain upon Montreal, and Wolfe by the St. Lawrence upon Quebec; both successful, and yet two years without connection. The delay may be regarded as a consequence of the enemy's defensive lines (also two in number) being internal, while the British were external; and success arose from the strategical operations being rather distinct zones than lines; and that the direction of Wolfe's upon the St. Lawrence, which brought on the battle of Quebec, severed the enemy from all connection with the other line and the interior; at the same time that by occupying the river both were entirely cut off from their fixed base in Europe.

In the American revolutionary war, we find isolated expeditions scattered over a vast continent, on no point constituting a superior army, and everywhere inferior to the local militias; traversing vast woody regions, and terminating their career in defeat and capture. More recently we see them dispersed along the coast, occupied in landings for trivial purposes, and when re-embarked, leaving the enemy the claims of successful resistance.

In British warfare, the Roman maxim, *never to act offensively on more than one point at a time* (always excluding India), is proved to be judicious by the history of events since the war of the Spanish succession, when that question ought to have been decided in the Netherlands. The evil consequence of pursuing a multitude of offensive combinations at the same time was never better exemplified than in the failures of the simultaneous expeditions to Buenos Ayres, Constantinople, Alexandria, and Rugen, in 1807. Small debarcations for inadequate objects on hostile coasts produce no advantage equal to the risk, expense, and hostility they foster; for the local garrison and militia of the country are soon superior in force, and a hurried return on board causes union and exultation in the enemy. The landings at St. Cast and at St. Malo; that of Sir James Pulteney at Corunna; at Alexandria and Rosetta; most of those on the shores of the United States, were fraught with danger, odium, and inadequate results. Those on the east coast of Spain during the Peninsular War form a clear exception; they had a political object of importance to hold up; an ally to join and sustain; and, above all, they served as a diversion which compelled a whole hostile army to remain in that quarter.

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Manœuvring lines, and those which nature has marked out, form separate classes.

Lines of Operation.

1. *Simple lines of operations* are those, when an army operates in a single direction from a frontier without forming detached corps. 2. *Double and multiplied lines*, when it acts on the same frontier with two or three isolated corps. 3. *Interior lines of operations* are so denominated when two or more corps are interiorly connected while they face an enemy posted exteriorly, whose connection is only by his flank or circuitous. 4. *Exterior lines* are such as armies form when they operate upon the two extremities of the enemy's front of operations, or on the two sides of two interior lines. 5. *Lines upon an extended front* are those which, though they be upon the same line, are separated into isolated divisions. 6. *Deep or lengthened lines*, such as commencing at the frontier basis, extend over a great space before they attain their object. 7. *Concentric lines* are those of several corps, or portions of corps, converging to one point. 8. *Excentric lines* are those of several corps, or portions of corps, *diverging* towards two or more points. 9. *Secondary lines* are those in the great combinations of armies which designate their relative connection while operating on the same frontier. 10. *Accidental lines of operations* sometimes are taken when the original plan of a campaign is altered by an unexpected event, such as being frustrated in an offensive operation and selecting a line of retreat towards a basis not in the original zone of operations, nor towards the starting-point of the first basis.

To illustrate some of these definitions, let us suppose two armies like the British and Prussian posted in Belgium with either offensive or defensive intentions, and their magazines in the rear (perhaps at Antwerp and Maestricht), these places would constitute the territorial lines they have to cover, and the manœuvring lines would be in their front and to their flanks: if an hostile force could place itself in their rear, about Brussels, they would be cut off from them. Now, if the allies separated, and the Prussians took post on the Meuse, towards Namur, then the enemy would be cut off from his own; but as in that case the British could not singly remain in its position, and therefore would fall back behind the Scheld or towards Dutch Flanders, to re-open the communication with Antwerp, then the allied armies would present two exterior manœuvring lines, and the enemy a single central line, re-opening his own communication directly with the French fortresses by a new or accidental line of operations, and attaining his object by mere strategical means. But if the allied armies preferred to attack him with united forces, as both parties would engage with the chance of being cut off, the victorious would necessarily ruin his opponent. The movements and battles of Waterloo and Wavre would nearly represent this supposition, if the enemy's forces had moved from their base by the right bank of the Meuse, Namur had been unoccupied, and the allies had suffered them to proceed without counter-manœuvres. So again, when Melas was defeated at Marengo, he was cut off from his temporary base on the Po; and with less jealousy and more enterprise, had he fallen back towards Genoa, and, instead of surrendering all the fortresses, given that city in charge to the English, he would, reinforced by the 10,000 men drawn from thence, and by the supply of *materiel*, which both the British naval stores and Piedmontese arsenals contained, have resumed the offensive: and if again defeated, the fleet would have carried his forces round without a surrender or the fall of any strong place, and the enemy would have been isolated in the plains without a single fortress. This instance is one of a most numerous class where theory makes a strong case; but circumstances were such that if they had been managed with skill, the results might have been very different.

In the first case is already shewn the superiority of a single line, and it as well

OFFENSIVE OPERATIONS. as interior lines have manifest advantages over every other, since they facilitate most the great principle of carrying a superior mass upon the decisive point; for an army marching from its base by a single line of operations, the Commanding General has only two momentous chances to provide against: 1st, that of being attacked unawares; and 2nd, of being turned and severed from his base. If he take the *initiative*, manœuvring with the intention of attacking, he will keep the adversary in check, and prevent a counter-offensive; and if, in these movements, he can gain the hostile line of territorial operations, or throw his masses centrally, so as to prevent the enemy's corps uniting, he may totally ruin him. This was the aim of Napoleon in 1815: his concentrated masses were alternately to crush an opposing army, while an inferior corps kept the other in check; selecting the offensive line from behind fortresses at his pleasure, he could fall upon the allies before they were concentrated. The plan of his operations was good, had it been acted on a day earlier; and a day later he would not have been allowed to become the assailant. His momentary successes were due to the operations of a single against double lines; but when his intentions were sufficiently developed, and when the necessarily extended positions were drawn together, the continuance of the same idea became rashness, for the two allied armies were united.

An army moving upon exterior, double, or multiplied lines, is weakened in proportion as it is subdivided: the casualties in its combinations are greatly increased by the chances of accidents, misunderstandings, non-arrival of orders, and delays; errors are not so readily discovered or rectified, and a single misfortune in any one part paralyzes the whole. To the vicious system here noticed, must be ascribed the greater part of the failures of the Austrians, and more particularly of Alvinzi in Italy; and the Seven Years' War is rich in examples of success and reverses, mainly to be ascribed to the use made of single and double lines of operations. In the wars of the French Revolution, little was done by either party, scientifically considered, that deserves commendation: external and excentric lines, permanent positions, great detachments, were adopted by all; with manœuvring armies on the side of the allies; a belt of fortresses, numerical superiority, and, above all, a geographical frontier, which made all the movements of the French army comparatively single against double; internal against external; a concentrated against a dislocated base; and, adding activity against tardiness, it finally triumphed through one great military principle adopted by Carnot for the first time, namely, to send a vast reinforcement in a body to the army of the left (Dunkirk), and having by this mass ruined the opponent (the Duke of York), to move it to the next, opposite Charleroy, where, being thus again vastly superior, it broke the grand Austrian army: then again, proceeding to a third (Sombre and Meuse), and finally to a fourth army on the Rhine, each in turn becoming thereby superior, success was obtained for the whole campaign.

Napoleon manœuvred always on single lines, and in directions to cut off his opponents from all their resources: his strategics and battles were ever on the same principle; and, adding to these extraordinary activity and daring, he prostrated all the continental powers. But his deepened or lengthened lines of operations became boundless; and his daring, rashness; still, the value of the true principles of war made him successful against the false maxims of the enemy. In the Russian campaign, his single and internal lines broke through the multiplied and extended lines of the Russians, till their depth, and the change of the Muscovite system after the battle of Borodino, aided by the climate, exterminated his forces; and new armies could not again restore the superiority. Meantime the Duke of Wellington began in the Peninsula by creating a military base; then, although he manœuvred with inferior forces, by carrying the mass alternately on the north and on the south of the

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From the results of the scientific campaigns of the last wars, the value of the principles above indicated may be summed up under the following heads:

1. A double line of operations is advantageous if the enemy likewise acts upon two lines, provided these be exterior and at a greater distance to operate simultaneously than your own upon the same field of action.

2. An army having interior lines, being more concentrated than those of the enemy, can by strategical movements destroy first one, then the other parts of his forces, by alternately carrying its masses upon each point,—as was exemplified by the King of Prussia in 1758, and subsequently in the revolutionary wars at Mayence, Würtzburg, Emendingen, at Lonato, Castiglione and Bassano, Stockach and Zurich, Abendsberg and Eckmuhl, as well as in the Peninsula, before noticed.

3. To effect this purpose a corps is left to occupy the attention of the army for a short period, by various movements, or by an intrenched position; in all cases to act really on the defensive, retarding the enemy's advance at defiles, bridges, &c., until, by slow retreat, time has been given for the main army to strike the intended blow, and then the order of operations is reversed by the retreating corps being reinforced, till it is in a condition to resume the offensive with superior forces.

4. Thus, with equal forces, an external double line will always be worsted by an internal, because these last, being in closer connection, can most readily reinforce each other, provided their Commander manœuvres with intelligence and rapidity. Even the ignorant energy of Tippoo Sahib proved in several wars the advantage of central operations against external lines, such as Lord Cornwallis and Abercombie, with their allies, used against him.

5. A double line of operations becomes still more dangerous when its parts are separated by several days' march.

6. Simple and interior lines, on the contrary, are always most safe; because they admit the mass of forces to act against the divisions of the enemy, if he be so imprudent as to leave one or more in that condition.

7. A double line of operations, however, may be adopted with success, if the forces employed so greatly exceed the enemy's as to outnumber them on both its parts.

8. Two interior lines, mutually sustaining each other, and facing two exterior

lines at a certain distance, must avoid being compressed into a small area, for the two hostile bodies might then co-operate simultaneously.

9. But they should not manœuvre at too great intervals, for the enemy, by a sudden advance on one, might have time to crush it while it is weakened by detachments to the other, and thus gain a decisive advantage.

10. It being the advantage of a Commander to divide and isolate an opponent's army, his manœuvres should never have the object of drawing his whole forces unitedly upon him, notwithstanding Tempelhoff's boast that Frederick the Great effected this in 1760.

11. When armies operating exteriorly amount to above 100,000 men on each line, as occurred in Saxony (1813), and in Champagne (1814), they possess a consistency that is not so easily affected by interior lines: they can recede and advance till the intervening area is so diminished that the forces within it risk to be simultaneously attacked, or they must escape in a direction least expected, that is, where the retreat is most baneful to themselves. Proofs of this law are found in the operations about Leipzig, and in the last strategical movement of Napoleon in 1814, by which he lost his communication with Paris and his crown.

12. But notwithstanding these events, concentrated lines maintained him in 1813 about Dresden, and the next year in Champagne, until yielding more to temperament than necessity he manœuvred excentrically with inferior forces at all points, and at the same moment in Bohemia, Silesia, and the sands of Berlin, and suffered reverses in all: so again the next year in France; while the allied forces were in extreme difficulty for subsistence, his impatience to act on the offensive broke through all the principles of war, and Paris was lost without an admissible reason. The history of individual and national temperament in war is indeed a subject replete with fearful lessons, if it were properly handled. Marlborough in 1711, counteracted by the ministry of his own sovereign, crowned the greatest of his manœuvring campaigns by forcing the French lines and the capture of Bouchain, solely by playing upon the temperament of Villars, whose irritable vanity is confessed in his own Memoirs. Had Eugene, the year after, counteracted the French march upon Denain, by boldly manœuvring across the Escaillon and Selles, upon their communications and rear, they must have immediately retreated or been cut off from their basis of operations.

In order to complete the view of territorial and manœuvring lines, it is requisite to consider them as they are affected by the configuration of frontiers, for the base of operations depends thereon, as is manifest from proofs already given.

1. Only one army should operate on the same frontier, though reserves, &c. may be kept in second line. That army is based usually on the last line of fortresses, the most defensible river, or mountain chain, whence offensive movements can proceed, and to which defensive refuge must be had with the greatest trust for safety.

2. An army may have successive bases. A French basis, defensively viewed from the side of Germany, would be primarily on the Rhine, second on the Moselle, third on the Seine, and fourth on the Loire.

3. A first basis becoming by the reverses of an army exposed to the enemy, its character is changed to a line of defence, particularly if there be fortresses upon it: thus the upper Rhine, a broad and rapid stream with fortifications on many points, forms an excellent base and defensive line; for none are good that have not more than one fortress upon them.

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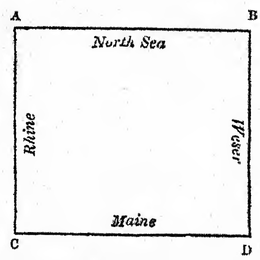
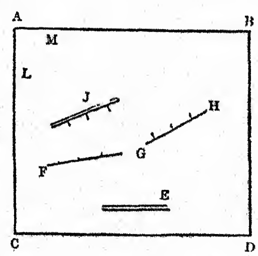
4. An army may operate offensively with advantage upon the centre of an hostile frontier, even when defended by a line of fortresses, as the Austrians under the Prince of Coburg did in Belgium in 1793–4, and the French under Pichegru retorted in 1794. The first failed from the detachment system, albeit the attack upon Dunkirk was advisable, to secure the right flank and keep open a more direct communication with British resources; but the grand army should have masked Lisle. The second was successful, not by the direction of his line of operations, but by the superiority successively given to each army by the able measure of Carnot, as already mentioned.

5. The best basis is that which forms a re-entering angle or two sides of a square; such as the French made of the upper Rhine and northern Switzerland towards Germany, or southern Switzerland and Piedmont on the Italian side; for they offer a double front of attack, outflanking an advanced hostile army, and a double facility of retreat.

6. Jomini points out the configuration of a theatre of war being in some measure quadrilateral; as for example, the French army in the north of Germany, from 1757 to 1762, and the operations of Napoleon in 1806.



The side A B being enclosed by the North Sea, the side B D by the river Weser, base of the army of Prince Ferdinand: C D representing the river Maine; base of the French and A C the Rhine, likewise in possession of the French: their armies operating offensively on the sides A C and C D, had the third A B or North Sea in their favour, and therefore B D was the only side they were to gain by their manœuvres to have possession of the four sides, and consequently to have the base of all the communications of their adversary. A diagram proving this still more clearly is found in the next figure.



The French army E, proceeding from the base C D to gain the position F G H, cuts off the allied army J from the side B D, its only communication and base. It would thus be driven into the angle L A M, which is formed near Embden, by the lines of the Rhine, the Ems, and the Sea; while the army E could always communicate with C D or the Maine. But though a re-entering angle of frontier, or of operations, as regards Switzerland and the north of Germany, are true upon systems of undisguised aggression and servile submission of the half of Germany to the gigantic schemes of France, the re-union of interests and national spirit of the Teutonic race will in future render similar undertakings much more impracticable. Two sides of a quadrangle present besides the inconvenience of double external lines, and may be treated accordingly.

Further discussions on the configuration of the territorial surface of a campaign occur in Jomini, where he reviews the operations of Napoleon against the Prussians and Russians; but as they are included in the foregoing demonstrations, and belong entirely to the gigantic system of that period, reference is recommended to the author, and it will be sufficient here to notice his two concluding maxims:

1. To move the masses upon the decisive point of the line of operations, that is, upon the centre of the enemy if his forces happen to be scattered, as the

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Russians were on opening the campaign of 1812, or upon an extremity if he is on a contiguous line.

2. To make the great effort in the case of a connected hostile position upon that extremity which affords no means of retreat, or which leads upon his communication without endangering one's own.

DEFENSIVE OPERATIONS.

Although these have incidentally been noticed in the foregoing pages, they still demand some further remarks. Passive defence—that is, where the troops are shut up in fortresses, or an army is intrenched without taking the offensive on the least prospect of advantage—gives no security to States, as was felt by the Dutch republic on more than one occasion. But as defensive measures imply inferiority of physical force, natural and artificial obstacles are made to contribute to restore the balance. That defensive system is the best which embraces the greatest number of offensive facilities, such as already adduced in the remarks on single and internal lines of operations; because they best anticipate and counteract the progress of invasion. Eminently serviceable are rivers with fortresses and têtes de pont on the opposite side, such as Prague on the Moldau, Maestricht on the Meuse, and particularly Coblentz with its whole system of defences, and Ehrenbreitstein on the German side of the Rhine. Namur on the Meuse is equally well calculated for this purpose; and if the vitality of Belgium were sought to be maintained, a fortified position between Lier and Antwerp, with the Ruppel and Scheld in the rear, would bid defiance to any hostile force from the south, because while all the great military and commercial interests are covered, the communication with the sea may be kept open by inundations, provided artificial strength were given to the front and flanks by timely well-constructed works. In all these cases the defensive army may place the river or the works between it and the enemy, as often as may be necessary; while the offensive force is obliged to cross and recross, or to extend his position in such a manner as to expose some part to be attacked and cut to pieces before it can be assisted. On the Danube the Austrians had an excellent defensive line; but not being anywhere secured by fortifications, to give the required facility to their movements on each side of the river, it failed to answer the purpose. Since the peace, excellent measures have been taken to obviate this want at Linz, Passau, and Ingolstadt; others are now in progress at Ulm; and the formidable position of Salzburg covers the Hereditary States from hostile approach through the Noric Alps. The insignificant fort Bard, in 1800, arrested for several days the principal column of Napoleon's army from coming down the St. Bernard into the valley of Aoste; and with slight additional attention might have deranged all the conqueror's projects, as before noticed. Again, the importance of certain defensive points is manifested in neglecting to secure the noble roads which Napoleon had constructed across the Alps; for the Austrians made two successful invasions into France by these, shortly after they were finished.

Fortresses likewise protect magazines, hospitals, and stores of an army, and save the matériel after a defeat. Prague in 1757 secured the Austrians; and Pampeluna, for a time, all that escaped from the rout of Vittoria. But in order to obtain from them the degree of security which can reasonably be expected, they should not be too numerous, because they demand such a proportion of troops for garrisons as to absorb whole armies; and the expense of construction is enormous: nor should they be small, for then they are easily crushed by the abundance of artillery now in use; nor all on the frontiers, because an enemy penetrating beyond them, the great arsenals, dépôts, founderies, &c. of the State are no longer in reach of the defensive army. The large cities or towns which happen to occupy intermediate sites on the great lines of defensive operations, between the capital and the frontier (and if pos-

DEFENSIVE OPERATIONS.

sible on a navigable river), should be selected, fortified with all the rules of art, and in some cases covered by an intrenched camp, and they should communicate with the seat of Government by established telegraphs. Camps defended simply by intrenchments of field-works, not solid fortifications, are more commonly the work of the eventualities of a campaign, and, on great fronts of defence, are seldom tenable. The Bavarian position on the Schellenberg in 1704 being unfinished, and with insufficient means of retreat, should have been abandoned: that of the Russians at Drissa upon the line of Moscow was abandoned: the French at St. Jean de Luz and Toulouse were carried by storm: that on the Isla of Cadiz was maintained in one war and lost in the next. The lines of Lisbon were maintained, and saved the kingdom. That of Dumourier, near the wood of Argonne, arrested the progress of the Duke of Brunswick in 1792; and that of Kutusoff at Malojaroslaf, near Tula, forced the French to retire by the route they came. Both these last were in the flank and rear of the offensive armies, and offer proofs (when circumstances do not permit that they be turned) how decisive they are of events when firmly maintained: one had fortresses at his back, the other a Russian winter in his favour. Bonaparte, in 1814, after the action of Brienne, vainly believed the allies would follow him towards the Rhine, when they were already at the gates of Paris, and by this enormous mistake lost the empire. To sum up defensive war in one maxim, it should be stated that "it does not consist in covering every part of a State, but in preventing an enemy from obtaining that object which will accomplish the end he has in view."

TACTICS. Battles.

The plan of a campaign and the strategical movements are both entirely directed towards victory, or so many preparatory dispositions to arrive at the successful crisis of a battle; therefore the rules applicable to them constitute the most important branch of the science of war, and unless they are well understood, all other knowledge is comparatively useless. But even here the direction of the line of operation, and then of tactical measures, is so influential, that an army may be manœuvred out of its defensive plan, and forced either to retreat or to fight on disadvantageous terms.

Though fixed rules are exceedingly difficult to be applied, still among the first is that of operating with a superior mass on the decisive point, because the physical force of organized numbers in arms furnishes the unerring element of victory, when the moral qualities of both armies are equal. The means of bringing this force to bear in the most advantageous manner is the art of fighting; consequently courage and fortune being nearly balanced, that General who can operate with the largest mass upon the most decisive point must be successful. But for this purpose the combination must be such as to produce a unity of movements, conducting simultaneously to the same object; and the masses so produced must act with energy against the enemy, for mere superiority on the given point without action would be useless; as was signally exemplified at Fontenoy, where less than half of an inferior army broke through the hostile position and then halted nearly four hours, waiting the reorganization of the enemy's line in order to be—defeated; or when Marlborough, attacking a superior force at Ramillies, judged that the hostile left and his own right could not act offensively against each other, while on the other flank of the enemy's army he perceived the household troops adding a great reinforcement to their right wing, drawn up on the plain and covering Ramillies, full of infantry. He therefore ordered his own right wing to make a vehement demonstration of attack, coming in two lines, sustained by all the right of cavalry, and under cover of a heavy fire of cannon, down the high ground to the marshy rivulet, and then to retire up hill till

the first line alone should remain in the enemy's sight. This manœuvre having been effected, part of the infantry and all the cavalry marched to their left and reinforced the left wing till it stood in four lines: Ramillies was then carried by storm, and the French cavalry, after a severe struggle, was finally routed, because the allied army fought with a reinforced wing still more efficient than the enemy.

The following maxims are of general application:

1. No favourable opportunity should be postponed to the morrow.

2. No battle should be given but for an important object, unless the circumstances render one unavoidable.

3. No battle undecided at nightfall should be considered ended until at least one more great concentrated effort shall have been made to convert it into a complete victory before total darkness produces the cessation of action. Napoleon on more than one occasion obtained his victories by such an unexpected effort, and particularly at Ligny owed his momentary success to this measure.

4. Per contra; the army which has firmly maintained its ground during a day of battle can with safety call in such corps as may have been posted in observation, before the points of attack were fully developed, and likewise draw the reserves from the rear as near as convenient, and be prepared to repel with vigour any final attack: or should it be made, to retort it by assuming itself the offensive; for then a panic may be created and the whole hostile army fall in confusion. Such were the measures taken by the Duke of Wellington at Waterloo, and the details of his last defensive position completely prove his army to have been prepared for that transition to attack before the last unavailing effort of the enemy was defeated, whereby his cavalry was at hand to break the squares of the French Guards and throw the whole into inextricable disorder.

5. After a victory the enemy should not be allowed to recover: fatigue must be disregarded, and the pursuit made incessant; for the enemy is surely as much exhausted as the conqueror: if he can flee, the other must be able to pursue: the troops should be concentrated as much as possible towards the close of a successful action, not only to complete the work satisfactorily, but to repel those last and desperate efforts which have more than once turned the fortune of the day.

As in lines of operations, so on fields of battle, it is necessary to avoid, 1st, forming isolated divisions; 2nd, ordering extended movements which deprive the army of a part of its strength, and enable the enemy either to ruin the main body or the detachment; 3rd, positions with too great an extent of front; 4th, suffering obstacles, rivers, ravines, &c., to separate the wings, or impassable rocks to intervene between the columns, exposing them to be separately defeated.

The finest combinations are,—oblique orders of battle; those with a wing reinforced; those which outflank the enemy; and those which produce a perpendicular line upon an extremity or a scattered centre of the enemy. These are, theoretically speaking, always successful, because they present a whole line to an extremity, and therefore bring into action a greater force than the enemy, in conformity with the fundamental law in all military combinations of "*effecting with the greatest mass of forces* a combined attack upon the decisive point." Even where the victory is ultimately lost, the manœuvre shews at what risk and price it must be met, as in the case of Albuera, where Soult's front came upon the right flank of the Spaniards with such rapid progress, that the British in the centre, in order to form a new front,

were obliged to extend the line at an angle to the rear, which was not effected but with great risk and loss.

To effect the purpose of the foregoing maxim there are many methods, though in general it results best from taking the lead in the movements, because

1. An army in that case can conceal the intended manœuvre until it is in full operation, either when commencing at the distance of one or more days' march from the enemy, or by the nature of the country when in his vicinity.

2. The Commander should not take into his calculations that the enemy will be informed of his movement, penetrate his design, and oppose it by the best possible means from the instant that it is begun. An ancient and signal example of turning a flank in sight of the enemy occurred at Flodden, where Surrey, with inferior forces, attacked the King of Scotland and cut off his retreat. At Prague, Prince Charles of Lorrain and Marshal Brown both saw the Prussian left, led by Marshal Schwerin, prolong their movement to outflank the Austrians; and yet, although the Imperial army stood in the open plain upon the chord, and their opponent upon the arc, had moreover a swamp to cross, in some places in single files, yet Warnery with his hussars arrived beyond the extremity of their right, and by this means turned the fate of the day.*

3. When two armies combine from the distance of several days' march to place the enemy between two fires, their dispositions must emanate from a double line of operations against one that is single, and therefore they must expose themselves to be defeated separately, if the enemy takes proper advantage of his central position. Such a manœuvre is similar to a movement made at a distance against the flanks, and belongs to those which cannot produce a simultaneous effect at the moment required. Such was the corps under Sir Ralph Abercrombie in the Helder expedition detached to Hoorn, and obliged to hasten back without seeing an enemy. Such was Grouchy's at Wavre, during the battle of Waterloo.

4. Another maxim of battle is to direct the movement against a weak point of the enemy, when that point offers the greatest advantages. An attack to the front is always unadvisable, when a concentrated effort can possibly be made upon the extremity of an enemy's line. Against double and scattered lines of operations it is preferable to direct attacks upon the central points; for the mass of forces having ruined a central division, the corps to the right and left of it can no longer operate in unison, and are forced to retreat excentrically, as was proved in the disasters of Wurmser, Mack, and the Duke of Brunswick, and at the close of the battle of Marengo, where Kellermann's cavalry broke through an opening in the Austrian line, and though superior in that arm upon the field, they had none present on the spot to remedy the consequence.

5. A deep column being attacked on the head is in a similar condition as an extremity of a line; both the one and the other are engaged in succession and defeated, or what is termed rolled back. Such were the events of Rosbach and Auerstadt. Bearing out the same principle which guides lines of operations, the manœuvres of attack on a battle field are equally decided by the same causes; namely, by decisive operations on the flank and rear of an enemy. Such was the manœuvre of the Duke of Wellington at Vittoria, and the success complete. Soult at Albuera and Junot at Vimiera aimed at the flank, and both

* Marshal Brown, forgetting his flank, charged the disordered Prussians with his grenadiers, and thus gave time to their cavalry to prolong the movement. Haddick's hussars trotted to the right, but were finally outflanked by half a squadron.

these events shew that counter-movements with resolute well-trained troops may defeat the attack, because the defensive army being on the chord or shortest line, can readily prolong its front to equal or pass beyond the assailant. The battles of Ligny and Waterloo belong to the principle of a double interior to two external lines modified into a single mass breaking in upon the centre of a scattered line,—Napoleon aiming at the two allied masses separately, by moving two-thirds of his force alternately against the principal army and keeping the other in check with the remaining third, until his first blow should be struck. He succeeded in the first part of his plan, but failed in the second, and from the headlong system of his battles his defeat was irretrievable and fatal. These battles, and those of the grand allied army when it debouched in 1813 from Bohemia upon Dresden, and when Napoleon retorted by sending the corps of Vandamme across the mountain ridge to Culm, also the detached force under Grouchy at Wavre, and the British late on the same day at Halle, attest that wherever detached corps are out of hearing of the cannon they become useless to the main operation, often are made to suffer so as to counterbalance a victory, or, when successful, are found to have produced no advantage equal to the risk.

It is to obviate the too frequent necessity of sending great detachments to cover the flanks of armies at some distance, that these are usually posted in strong or in partially fortified towns, where the defences should always be placed in that condition of resistance by means of closing the gorges of bastions or loopholing and strengthening particular buildings; for thus a less force may retain them until relief can come and the masses of the army are less reduced.

Enough has been said on the advantage of attacking the extremity of a line and the conditions which allow the onset to be carried against the centre of a scattered line: to these may be added the only case when both extremities may be attacked; and that is, when the assailant is possessed of at least double the numerical force of his opponent: for then it is important to bring into action at the same moment the greatest possible amount of that superiority. Such was the occasion which caused Daun to attack the Prussians in this manner at Hochkirch; and again, when the allied armies fought at Leipsig.

Inferior corps have sometimes acted offensively in a divided form: this was the case at Kollin by an improper execution of the intended system of battle; for Frederick II. had theoretically in view an oblique attack; but his generals and he himself were as yet so little competent to work it out, that the army formed no contiguous mass, and became parallel to Daun's front. At Crevelt an inferior corps turned the flank of an enemy who was superior in force, but ill commanded.

All fields of battle have a decisive point or key. It is not, however, always to be found in the strongest part of the position, but generally where the communication with the base of operations is most readily cut off; for if an army is forced on the other extremity, it may retire with little more loss than the assailant. When the lead is taken in operations, it becomes of the utmost importance to be exactly informed of the nature of the country in front, and still more of the enemy's movements and positions: spies are then of great use, but still less so than partisans thoroughly versed in the art of watching an enemy with small detachments: these should consist of parties of light cavalry added to infantry where the ground will permit. The celebrated Lloyd was remarkable for the talent of conducting these apparently small operations, which, nevertheless, though too much neglected, are often the cause of safety and of victory, and therefore require a careful training, with

a selection of the most intelligent officers to command them. It is the best practical school of war.

Battles are either offensive or defensive; therefore, what is recommended to be done for gaining the first is most to be guarded against in the second. They are reducible to three systems: 1, includes defensive battles where the enemy is expected in a strong position with no other intention than that of maintaining it. Such were those of the French under Tallard at Blenheim, of Villeroy at Ramillies, of Marsin at Turin, of Villars at Malplaquet, of Saxe at Fontenoy, Daun at Torgau, and the results shew their general disadvantage. 2, is the opposite system, wholly offensive. It consists of movements of attack wherever the army may be found. Such were those of Marlborough at Blenheim, Ramillies, and Oudenarde; Frederick at Leuthen, Zorndorff, and Torgau; Napoleon at Jena and Ratisbonne; Wellington at Vittoria; and the allies at Leipsig. 3, is the middle term between the above. It consists in selecting a position carefully reconnoitred beforehand in its strategical applicabilities and advantages of ground; there to await the enemy, and to fix upon the proper moment of passing from the defensive into offensive measures with the best chances of success. To these belong the battles of Rivoli and Austerlitz, of Blucher at Katzbach and Laon, and of Wellington at Salamanca and Waterloo. The selection of the class of action is not always optional; the circumstances of the moment, the character and number of the troops in hand, the season and nature of the country and ground, all enter into the consideration, and leave only the following generalities for data.

Orders of battle, or the most appropriate disposition for leading troops into action, should possess the inherent qualities of mobility and solidity. To attain these two objects, troops which are to remain on the defensive should be partly deployed and partly in column, as the allied army was at Waterloo, and the Russian at Eylau. But the corps destined to attack a decisive point should be disposed into two lines of battalions formed into columns. Such were the British at Roleiça, and the centre and left of Napoleon's grand army at Dresden. Each column may be in grand divisions of battalions, and if it is considerable in depth, may be best formed on two central grand divisions, which, moving forward contiguously, readily constitute a line by each marching up obliquely to right and left. A beautiful example of this formation was produced by Marshal Lehwald at the battle of Jagerndorff.

1. The best mode is to act offensively on all occasions when the troops are inured to war and the ground offers no extraordinary features, especially

2. When the strategical circumstances of the parties are such that one is obliged to attack the other without considering the localities; as for instance, to prevent the junction of two hostile armies, or to crush an isolated corps, &c.

3. But the defensive is advisable where the topography of a field of battle is difficult of access, from natural or from artificial causes, and the army is composed of different nations trained in different manners and imbued with different feelings: it is preferable to receive the attack in a well-selected position, with the determination of assuming the offensive when the enemy shall be exhausted by the first efforts.

4. Also when particular reasons, such as an extreme inferiority of numbers, forbid any other than strictly defensive measures; such as Eugene took at Chiari, Abercrombie on the Zyp, and Moore at Corunna.

There are strategical battles so much affecting the flank and rear or the com-

munications of the defensive party, that sometimes they are decisive of a campaign: such was that of Marengo; and again, as a battle, more complete at Vittoria.

Orders of Battle. Battles, again, whether offensive or defensive, notwithstanding all the varieties of ground and changes of position, are reducible to three orders; each subject to some modifications.

1. The simple parallel order, or that where the hostile forces face each other in parallel lines, to advance or receive the attack. In these, accident or some condition of superiority in courage, artillery, or discipline, decides the contest, and not the capacity of the commanding General.

2. Where no other combinations are practicable, there is the second order, or that with parallel lines reinforced upon one extremity. To this class, especially if dispositions with an angle to the front or rear are included, most of the great victories of ancient and modern times may be ascribed; for although it is not the most perfect in theory, it is the most constantly applicable in practice, under almost every possible character of ground or counter-disposition of the enemy.

3. The oblique order of battle is the third and the best class of tactical dispositions; but in the application great simplicity of combination is necessary, and great prudence in the execution. Against a manœuvring army well commanded it will always be difficult to apply it; but when produced the effect is instantaneous and decisive: it is the triumph of discipline and of grand manœuvre.

Positions. On the extensive subject of position, the following maxims offer some particulars. 1. The best military positions cannot cover a State merely by being occupied and maintained. 2. Every position has two keys or decisive points: one is the strategical, whereon the army hinges in relation to its communications with the base of operations; and the other, depending on the nature of the ground, is the topographical, which being attained by an enemy, dispossesses the defendant. In this case the defeated army, as at Neerwinden, in 1693, and at Neerlanden, in 1793, is merely driven back upon its line; but in the first-mentioned it is cut off from it as the French were at Vittoria, and therefore the result, if properly followed up by the conqueror, is always disastrous to the routed. 3. An army in position to risk a battle on the spot should have the front and flanks most carefully reconnoitred and watched, its internal communication opened and connected, and, if there be time, the roads in rear, to the distance of a march at least, examined and sketched. 4. Strong corps are not required to watch the avenues; the service is performed better by numerous small posts. The practical importance of the two last rules is exemplified by the surprisal of the Prussians at Hochkirchen, of Korsakow at Zurich, and Murat at Tarutina. 5. On ground of difficult access, such as gardens, enclosures, marshes, rivulets, vineyards, steep heights, &c., the defensive line should be deployed and covered with skirmishers; but the corps destined for attack are best in columns formed on their centres. At the proper moment these should be flung upon the enemy in the same order. If it be desired to display a greater front of line, a part may be deployed, behind which close columns should be concealed. 6. A superior army should never wait to be attacked, still less wholly deploy into line: if compelled to remain in its post, no more troops should be formed in line than are requisite to repel the enemy, while the remainder, formed in columns, should be so placed as to strike a decisive blow, as Lord Hill's corps did at Waterloo. 7. Villages, farms, or cassinos covering the front of armies, should be occupied by light troops

and detachments lining the enclosures and walls, the roads passing through them armed with cannon, the first line being sufficiently near to sustain and be sustained by them, and the outlets to the rear open. The events at Blenheim, Ramillies, and the château of Hugomont at Waterloo, all attest results according as this principle was well or ill applied. 8. An army appuyed perpendicularly upon a river should not be attacked on that side, because the enemy changing front en masse towards the stream, it might be hemmed in between the foe and the water. Now if the principal attack is made on the other wing, that chance is in favour of the assailants, because the extremity being turned, the whole line will be forced back upon the river. This would have occurred to Hiller's corps at Wagram, if a timely retreat had not saved it; and a similar fate awaited the French at Talavera de la Reina, had they persisted in an attack upon the Spaniards. 9. A repulsed attack should not be pursued unless the result has been decisive, because it might be the intention of the enemy to draw the forces out of their advantageous post,—a stratagem of great antiquity. 10. Positions may be occupied in an apparently disjointed form, provided they have the required facility for timely re-union. Several are indicated in the secret instructions of Frederick II.; and that at the siege of Olmutz, where he had a corps at Littau, while he remained with the covering army at Prosnitz, and in order to connect the two masses at will, a smaller on the hill of Hrad, between Namiest and Laskow, to serve as an intermediate point, is very remarkable. Orders were given to the corps at Littau, in case of attack, to retreat towards the King's, and if a superior force attacked the covering army, he was to retire towards the other; but if timely warning was received, all were to unite in the position of Gross-Jesnitz. 11. No position should be attacked on its strongest point, as the Austrians did at Breslau; but if the hostile position be prolonged by a detached corps, the principal effort should be directed against it; because, if that be defeated, the main body is turned and the affair decided. 12. Armies may be posted behind a ridge of hills, with defensive points upon the summits. These should not be attacked without an exact knowledge of the position they cover, and precautions taken accordingly. The events of Austerlitz and on the Katzbach prove the necessity of precaution, and at Lowositz the neglect of occupying the hills was the cause of Marshal Brown's defeat, and of the Saxons being captured at Pirna. 13. Neither position nor plan of attack admits the line to be intersected by any impediment, such as a river, morass, or deep ravine, because the enemy may act defensively on one side and offensively on the other, as happened at Dresden, where the left of the allies, separated from the line by the ravine of Plauen, was severely handled. 14. An army immoveably fixed in a position may be turned on both flanks. Attempts on either, however, should be met by prolonging a flank, as the British effected to the rear at Albuera. 15. There are positions which cannot be turned or attacked obliquely. If the enemy cannot be induced to quit such by stratagem, the best mode of attack is by the centre, strongly reinforced; but still such positions often may be masked by small corps, because the nature of the ground, which renders them unassailable, is likewise an impediment for debouching from them.

Attack. Angles or formations en potence and oblique attacks have been repeatedly noticed in the foregoing pages. As both are thoroughly understood by military readers, we may refer those who wish to search further into these questions to 'War,' Encyclop. Brit. 6th edition, and Jomini, 'Précis de l'Art de la Guerre.'

Marches, however, in columns to the front flank or rear, which must terminate in deployments or échellon formations, are fit only for the elementary tactics of reviews; they can never be safely applied on a great scale before an enemy. The present system of moving by corps obviates much of the older organization by lines,

and renders the march manœuvres of Frederick less applicable; nevertheless, they are still the best for corps that are obliged to manœuvre in the presence of the enemy, and especially for the class and number of troops usually available in British expeditions, whether it be to engage in front or to turn his flank. An examination of the mechanism of the Prussian columns at Kollin, Leuthen, &c., proves that the army forming two lines, each broke into open column and moved in prolongation of the direction they both received, either with the right or left in front: by this method the army could,—1st, execute all necessary movements united, without danger of being assailed in detail, because the columns of lines were not further asunder than is requisite for battle. 2nd. The enemy could neither cut them off nor penetrate between them. 3rd. In taking the direction of the intended line, the army when reaching the ground is formed in a few minutes, that is, in the space of time required for the word of command to pass down the columns *to wheel into line*. In this method the only precaution required was to keep an advanced guard at first on the head of the columns, then as they passed obliquely towards the hostile flank to have it posted between them and the enemy, protecting the march, and by occupying intermediate heights dislodge the enemy's posts of observation, and in this manner conceal the intention of the manœuvre; the enemy thereby being kept in suspense, and consequently immoveable. 4th. As the army takes only two or three hundred paces between the columns and the divisions, no more than their respective distances to form into two lines, the manœuvre is easily executed with precision. 5th. The flank of the enemy being attained by concealing the movement, as before noticed, the rapidity of forming by merely wheeling into line will anticipate the hostile extremity forming an angle or change of front; consequently he will be overpowered and rolled back as fast as the new division to the front advances. 6th. If two columns of the length of the line of battle are not desired, or the ground requires a modification, four columns may be formed by doubling up the lines, or by marching by wings without increasing the difficulty of forming; the only precaution requisite being that the second and fourth halt in proper time, leaving the first and third to proceed until they have disengaged their rear from the heads of the other two. While halted, they protect the march of the two in motion, and then follow in their track or wheel into line, as may be ordered.

Orders of open columns marching to a flank are in truth manœuvres, not route marches; they answer best against lines in position and columns of deployment, and even against columns of march, if the movement against them can be prolonged unperceived, as was the case at the battle of Rosbach. But an open column taking ground on a field of battle, supposing the right to be in front, cannot change the direction of its head to the left, if, according to the regulations, all the sections must wheel into line on their true or left pivots; for then it would present the back to the enemy. Such a case occurred at Laswarree, where the British infantry, marching to the field, the column with the right in front, after crossing the Mahnusnye, a deep sunken rivulet, found itself proceeding against the enemy's right; but that wing drawing back into a new alignment, and forming an angle to the rear, a prolonged movement in this direction would have produced a parallel order of battle, and exposed the line to seventy pieces of cannon: advantage was therefore taken of a ravine which led to the right flank of the new position, and accordingly the column turned to the left; and by so doing, when it arrived at the point to form several battalions, in obedience to the rules and regulations, wheeled into line and stood with the back to the enemy, requiring to be countermarched under a storm of grape shot, and leaving, by this delay, all the brunt of the action upon the 76th regiment, and about two battalions of Sepoys. These remarks, it is true, belong to Logistics,

but they are mentioned here to shew the propriety of some alterations in the regulations. The flank movement, though ably conducted, was nevertheless countermanœuvred by the formation en potence to the rear, and the decision of the day was due to a charge with the bayonet. An army in column, however, finding itself suddenly in presence of one in line at right angles, has no other resource than to endeavour to deploy the leading brigade, while the next behind it changes the direction towards a flank; converting thus a probable defeat into an offensive movement and oblique attack, which will check and intimidate the enemy without incurring confusion.

Retreat.

Retreats are operations in war of all others demanding steadiness and cool self-possession. An army that is routed and turned can seldom maintain sufficient consistency to effect an orderly retreat; one that is merely dislodged from a position, not being dislocated, may retire without disaster, as the Austrians and Prussians have often effected; but the finest manœuvring operations belong to those who find it expedient to retrace their steps towards the base of operations without having lost a battle. Massena's retreat out of Portugal; the three, and in particular, the last, of Lord Wellington's out of Spain, are remarkable. The concentric retreat of the Russians in 1812, and especially of the left corps under Bagration, again deserve high commendation.

In the choice of a defensive position, considerations regarding a safe retreat should never be omitted. Waterloo, notwithstanding Napoleon's condemnation of it, was admirable for this purpose, because no pursuit en masse could take place beyond the depth of the field of battle, where the edge of the forest of Soignies gave immediate shelter to broken infantry, and the several broad roads through it the means of withdrawing the matériel. Mont St. Jean set on fire would prevent the pressure of columns by the great road; and if the allied armies had been there divided, by the French breaking through the interval between them, the British could easily fall back behind their right across the Haine to the heights of Anderlecht, while the Prussians falling back to Wavre could not be arrested by Grouchy. As neither of the allied armies, though worsted, could have been dislocated or unable to resume active operations, it would have been a most questionable enterprise for Bonaparte, to plunge into the forest of Soignies with not half his cavalry remaining mounted, while both hostile forces were in his rear and flanks with decided superiority in horse.

Retreats must be regulated by circumstances: if, for example, the army can screen itself behind a broad river, a chain of mountains or of fortresses, in one or two marches, it may be best to divide the forces into several corps, in order to attain that object with the least delay and impediment; but in general it is best to remain concentrated, contesting every point by means of a strong rear guard, the Commanders of which should be particularly careful to assign beforehand rallying points, in case any corps should be broken. Much may often be done, on these occasions, by the Engineers forming small defensive *palanka** redoubts, always the work of a few hours; and for this purpose all the regimental pioneers in the army, with a few battalion officers, should be placed at their disposal: these and the Sappers will be sufficient for works, and will contribute in making abattis, destroying bridges, and rendering boats unserviceable to the enemy. A retiring army is not always obliged

* Stockades with the posts left of unequal lengths, as supposed to render the escalade more difficult: the joinings of these palankas are sometimes covered by a second row, breast high, so as to render the whole musket-proof at all points.—Vide 'Stockade.'

to fall back upon its own base: sometimes the direction may be changed to a new one, as Frederick II. did in 1758, when, raising the siege of Olmutz, instead of returning into Silesia, he changed his line and marched into Bohemia. Napoleon was advised, before the battle of Leipsig, to change his to the Elbe, and manœuvre between Magdeburg, Hamburg, and Wesel.

Pursuit.

Pursuits should be conducted upon the same principles as strategical lines and battles, always aiming at the communications of the flying enemy; but in this case more than any, no relaxation should be allowed,—no time for the re-organization of his broken corps, or for preparing means to retard the pursuer. If his communications can be turned, it may be expected that the whole matériel of his army will be captured. The pursuer should disregard having his most advanced troops checked or even repulsed; he may be sure the enemy cannot continue to hold his ground, and therefore should attack him again and again, till he obtains his object: if he can drive the fugitives to the shores of the sea, a great lake, or deep river, he may compel them to surrender; therefore no battle gained should be without a pursuit to the utmost, provided no unanswerable objection be opposed to it.

Sieges.

Sieges, in Lloyd's opinion, should never be undertaken but for the following objects. 1. "When a fortress is situated upon the passage which leads to the enemy, rendering it impossible to penetrate further without the capture of it. 2. When a fortress intercepts the communications, and the country is unable to furnish the necessary subsistence. 3. When a fortress is wanted to facilitate operations by covering magazines formed in the enemy's country. 4. When the enemy's principal dépôts are within one which being captured would cripple his future ability to keep the field. 5. When the capture of a fortress produces the conquest of a considerable portion of country, and enables the besieger to winter in that vicinity." To these might be added,—6. The recapture of a fortress essential in the defence of a frontier.

Although the wars resulting from the French revolution were carried on with such a prodigious number of forces on both sides, that the ordinary rules of war were often safely disregarded, and sieges in particular were but little put in practice, yet during the whole of their course British armies and their allies have repeatedly failed in necessary sieges, and thereby endangered the success of a campaign, if not of the whole war, from the want of a sufficient establishment for the Engineer department: it was not until the last years of the struggle, when blood and treasure, so often wasted in vain, produced the conviction of ameliorating that most important arm in the service; and it is a naturally great satisfaction to the Army to see continued practical improvements in the operations of the Engineers,—the experiments with mines, pontoons, &c., sedulously encouraged by the head of the Government.

Covering sieges is best performed,—1. By the army advancing to attack the force which attempts to relieve a town besieged: it is the best mode to produce a speedy surrender. 2. If the enemy approach with an imposing mass, the siege should be raised; all the forces united, in order conjointly to give battle. 3. If a victory is obtained, the siege may be resumed, while the pursuit continues and the enemy is not in condition to return before the capture of the place. 4. A siege undertaken in consequence of anterior success should have the covering army, not near, but as far remote from the place as it can push the enemy; for a retiring army finds the difficulty of success increased by the distance it is from the place; but if at length the force approaches so near as to furnish a probability of raising it, the besieging corps should rapidly join the covering army, and make an united effort to defeat the enemy.

Logistics.

Logistics in continental armies embrace the practical art of moving corps of troops. It has been questioned whether the term applies solely to details, or whether it forms the general science of all the most essential parts of the art of war; or finally, whether it is simply a vague expression to denote the several branches of the service of the Staff; that is, the application of practical means to adapt the speculative combinations of the art to actual service. The word *Logistique*, in French, is derived from *Logis* (quarters), and therefore was originally applied to the duties we consider to belong to the Quarter-Master-General's department, and thus at first implied castrametation, cantonments, and marches. The late system of war having greatly altered the combinations, the Staff duties became more complicated, and thence resulted the practice to have in each army and corps, a Chief of the Staff, who united in his person, under the General, all the essentials of his office: to him therefore it fell to communicate the intentions of the Commander-in-Chief to the most distant parts of the theatre of war, and to procure for him all documents to aid in the formation of his resolutions. Being thus associated with his chief in all the combinations, obliged to transmit and explain them, even watch their execution in general and in detail, his functions necessarily extended to all the transactions of a campaign. Thus the Chief of the Staff was called upon scientifically in all branches of the art of war; and from that time the earlier interpretation of the word *Logistique* became utterly incomplete. The works of A. D. Charles, Guibert, Laroche Aymon, Bousmard, and De Ternay, are insufficient, and an express comprehensive treatise on this subject is become an object well worthy the attention of every Government.*

The authorities which have been consulted are chiefly—Guibert; 'Œuvres de Jomini;' 'Traité de Grande Tactique;' 'Guerres de la Révolution;' 'Précis de l'Art de la Guerre;' Lloyd, 'History of the Seven Years' War;' Tempelhoff, 'Geschichte des Sieben-Jährigen Kriegs;' Frederick, 'Histoire de Mon Temps;' 'Art de la Guerre de Main de Maître;' 'Instructions à ses Généraux, Instructions Secrètes;' Rogniat, 'Considérations sur l'Art de la Guerre;' Warnery, 'Œuvres du Général;' Carnot, 'Traité;' 'Die Bellona;' 'Die Minerva;' Scharnhorst, 'Militärisches Taschenbuch;' 'Militärisches Journal;' 'Nähere Beleuchtung des Mack-Zugeschriebenen-Operations-Plan;' Bülow, 'Betrachtung über die Kriegskunst;' 'Geist des neuern Kriegs System;' le Prince Charles, 'Principes de la Stratégie,' Vienna; 'Militärisches Zeitschrift;' 'Campagne de 1799;' Dumas, 'Précis des Evènemens Militaires;' Von Gross, 'Hist. Mil. Handbuch für die Kriegs Geschichte, 1792–1808;' Vaudoncourt, 'Campagnes d'Italie en 1813–1814;' Coxe, 'Life of Marlborough;' Pasley, 'Essay on the Military Policy and Institutions of the British Empire;' Jones, 'Journals of Sieges;' Napier, 'History of the Peninsular War;' Ferussac, 'Bulletin des Sciences Militaires;' La Roche Aymon, Gay-de-Vernon, Schmettau, Müller, &c., &c., &c.

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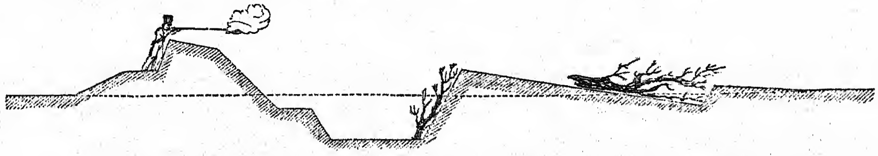
* We were here favoured with an interesting syllabus of the functions of the Chef de l'Etat-Major, such as might have devolved on Berthier, or, latterly, Soult; but this arrangement being so completely at variance with British practice, and being of questionable expediency, the statement given by Colonel Smith has been omitted.—EDITORS.

A.

ABATTIS should be so placed as not to be exposed to the fire of artillery. In redoubts or intrenchments they are usually fixed in an upright position against the counterscarp, or at the foot of the glacis, the plane of which last is broken so as to permit of their being laid out of the enemy's sight, and so as not to interfere with the musketry fire from the parapet in their rear.



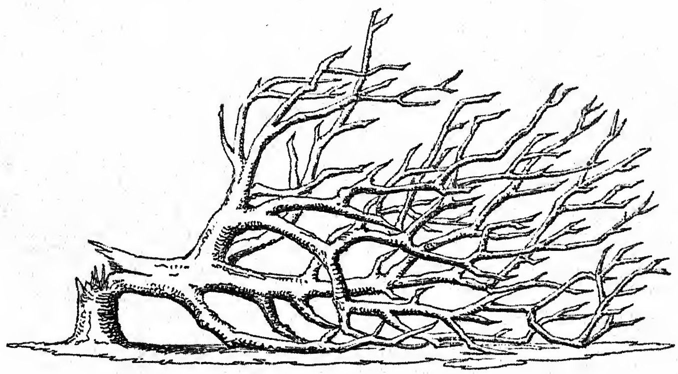
Abattis is an excellent mode of blocking up a road; and when the branches are well and properly placed, and interwoven one with the other, the disengagement of them is extremely difficult; and to form an opening sufficient for the passage of artillery, or even of cavalry, requires a long time. An abattis can easily be made by a few men, with half-a-dozen felling-axes and a cross-cut saw, and in a short space of time, if trees of sufficient size are near, or on, the spot: it is more easily formed, and gives a more effective defence, than palisades.

An abattis should not be planted out of musketry range; for this, and all other obstacles, are to break up the order of the enemy's advance; to impede, and to keep him under musketry fire.

The application of the abattis should be considered as purely local, and not one of the common resources for securing intrenchments, such as palisades, chevaux-de-frize, and fougasses; the materials for the construction of these last being capable of conveyance from a distance.

Hence, localities may enable the Engineer to obstruct a road by dragging trees from the hedge side; and connecting the defences of a position by levelling groups of trees with their branches towards the enemy.

Shrubby trees are not adapted to form a good abattis; they are easily forced, and drawn out by the hand; heavy trees, with the trunk cut half though, form insurmountable obstacles: this last is called an *Entanglement.**



* This improvement on abattis is due to Colonel Sir William Reid, K.C.B. & R.E., who used it with success in the Peninsula.

Abattis will always be found a very useful and effective auxiliary to the defence of picquet-houses or isolated posts, if judiciously placed within range of musketry: if placed close in front of the windows on the ground-floor, or to cover the entrance door, it will be extremely difficult for the enemy to force his way into the building.

In field-works it is very often equally difficult to procure timber to form a barrier to secure the gorge; this may be readily effected if trees are within a short distance of the works, by blocking up the entrance with an abattis.

AMMUNITION.—See also PYROTECHNY.

The following Table refers to Sea Service as well as to Land Service Ammunition; the whole being prepared by the Ordnance, chiefly at Woolwich, and supplied for either of the above, as demanded on requisition, Naval or Military.

General Table of the Ammunition of Ordnance, &c., shewing the nature and weight; also the dimensions of the boxes or packing cases usually employed in Stowage and Transport; their weights, empty and filled; contents and numbers, as numbered in the Pattern Rooms at Woolwich.

		Weight of 1.	Number of Contents.	Weight of Box.		Exterior dimensions of Box.			Number in Pattern Room.
				Empty.	Filled.	Length.	Breadth.	Depth.	
		lbs. oz.		lbs.	lbs. oz.	ft. in.	ft. in.	ft. in.	
68-pr.	Grape, quilted	50 8	3		176 8	2 2¼	,, 10¼	1 1½	
	Grape in case	50 15	3		177 13	,, ,,	,, ,,	,, ,,	
	Common shells	42 2	3	25	151 6	,, ,,	,, ,,	,, ,,	1
	Round carcass	48 ,,	3		169 ,,	,, ,,	,, ,,	,, ,,	
	Spherical case	61 4	3		208 12	,, ,,	,, ,,	,, ,,	
	Common case	47 5	3						
	Oblong carcasses		3						
	Oblong light balls	35 13	3	28	107 7	2 2¼	,, 10½	1 3½	2
42-pr.	Grape	41 7	4	28	193 12	2 5¼	,, 9	1 1¼	3
	Spherical case	38 2	4		180 8				
	Case, gun	44 ,,	4		204 0				
	Case, carronade	32 13	4	28	159 4	2 5¼	,, 9	1 3¼	4
	Grape, carronade	38 6	4		181 8				
32-pr.	Case, gun	35 1	4	27	167 4	2 2¾	,, 8½	1 2½	5
	Grape, gun	29 13	4	23	142 4	2 2¾	,, 8½	1 0¼	6
	Case, carronade	20 15	4		106 12				
	Grape, carronade	29 8	4	23	141 ,,	2 2¾	,, 8½	1 0¼	7
	Spherical case	29 ,,	4		139 ,,				
	Round carcasses	23 3	4		115 12				
24-pr.	Case, gun	24 2	6	21	165 12	1 7½	1 1½	1 1½	8
	Case, carronade	16 3	6	25	122 2	1 6¾	1 1½	,, 9¾	9
	Grape, carronade	20 ,,	6		142 ,,				
	Grape, gun	20 10	6		145 12				
	Oblong carcasses		6	22		2 4¼	,, 10½	,, 9	10
	Light-balls	9 11	6		80 2				
	Flan. cart., 8 lb.	8 2	6		76 12	1 6¾	1 0½	1 3	1 c
	Round shot, strapped	24 7	6		165 10				
	Case, iron ends, How.	16 3	6	19	116 2	1 7½	1 1½	,, 9	11
	Carcasses, round	14 3	6		104 2				
	Shells, common	14 15	6		108 10				
	Flan. cart., 2½ lb. How.	2 9	12	24	54 12	2 4¼	,, 10½	,, 9	10 c
5½ in. How.	Spherical case	21 14	6	27	158 4	1 9	1 2½	,, 11	12
	Common case	14 11½	6	22	110 5	1 · 7½	1 12	,, 10¾	13
18-pr.	Case, gun	19 11	8	23	180 8	1 10¾	1 0¼	1 0¾	14
	Case, wood ends		8						
	Round, strapped	18 6	8	20	167 ,,	1 10¾	1 0½	,, 9	15
	Carcasses, round	11 13	8		114 8				
	Spherical case	15 11	8	24	149 8	2 1¼	1 1¼	,, 9	16
	Grape, carronade	15 8	8		144 ,,				
	Grape, gun	16 12	8	20	154 ,,	1 10¼	1 0¼	,, 10½	17
	Flan. cart., 6 lb.	6 1½	8	25	73 12	1 10¼	1 1	1 2	2 c

TABLE—*continued.*

		Weight of 1.	Number of Contents.	Weight of Box. Empty.	Weight of Box. Filled.	Exterior dimensions of Box. Length.	Exterior dimensions of Box. Breadth.	Exterior dimensions of Box. Depth.	Number in Pattern Room.
		lbs. oz.		lbs.	lbs. oz.	ft. in.	ft. in.	ft. in.	
12-pr.	Case, gun S.S.*	11 14	12		168 8				
	Grape gun	11 1	12		158 12				
	Grape carronade	10 9	12	26	152 12	2 5½	,, 11¼	,, 10½	18
	Case carronade	8 4	12		125 ,,				
	Case howitzer	11 8	12		164 ,,				
	Round, strapped	12 8½	12		174 ,,				
	Carcasses, round	8 4	12	24	123 ,,	2 5½	,, 11	,, 8½	19
	Shells, common	8 8	12		126 ,,				
	Spherical case gun	10 14	12	25	155 8	2 8½	,, 11½	,, 6½	20
	Spherical case how.	10 ,,	12		145 ,,				
	Case Land Service gun	17 4	6	17	120 8	1 3¼	,, 11¼	1 0¼	21
	Case Howitzer or 4⅗	8 4	12		120 ,,				
	Carcasses, oblong		12	21		2 5¼	,, 11¼	,, 9¾	22
	Light-balls	5 4	12		84 ,,				
	Fl. car. gun, 4 lb.	4 1	12	26	74 12	2 4¼	,, 10¾	1 0¾	3 c
	Fl. car. how. 1 lb. 4 oz.	1 5	36	27	74 4	2 0¼	1 0¼	1 1½	11 c
	Fl. car. how. 1 lb. 14 oz.	1 15	24	24	70 8	2 2¾	,, 10½	1 1	12 c
9-pr.	Case, gun	13 2	12	23	180 8	2 3	,, 10½	,, 11½	23
	Grape, gun	8 12	12		128 ,,				
	Case, gun S.S.	9 10	12	23	138 8	2 3	,, 10½	,, 10	24
	Grape, carronade	9 1	12		131 12				
	Round, strapped	9 2	12	18	127 8	2 3	,, 10½	,, 7½	25
	Case, carronade	6 7½	12		95 10				
	Spherical case	8 2¼	12	23	120 11	1 4½	,, 11¼	1 2	26
	Flan. cart. gun, 3 lb.	3 1	12	23	59 12	2 1½	,, 10½	,, 11¾	4 c
6-pr.	Round, strapped	6 1½	24	24	170 4	2 0½	,, 9¼	,, 11¾	27
	Case L.S.†	8 13	12		139 12				
	Case S.S.	5 10	24	23	158 ,,	2 6½	1 1	,, 8¾	28
	Grape S.S.	5 6	20		130 8				
	Case, carronade	4 9	20	23	114 4	1 8¼	,, 9¼	1 2½	29
	Grape, carronade	5 2	20		125 8				
	Spherical case	5 7½	24	29	160 4	2 3¾	,, 10	1 ,,	30
	Flan. cart. 2 lb.	2 1	24	31	80 8	2 6¼	1 ,,	,, 11½	5 c
	Flan. cart. 1½ lb.	1 9	24	28	65 8	2 6¼	1 ,,	,, 9½	6 c
3-pr.	Round, strapped	3 1	30	18	109 14	1 4¾	,, 10¾	,, 10½	31
	Case, L. or S.	4 3½	30	25	151 9	2 6¼	,, 10½	,, 8¾	32
	Grape, gun	2 9	30		101 14				
	Fl. cart. 1 lb.	1 0½	30	26	56 15	2 6¼	,, 10¼	,, 10	7 c
	Fl. cart. 12 oz. fixed to rd. shot	3 13½	12	21	67 2	1 7¼	,, 11½	1 ,,	8 c
	Fl. cart. 12 oz. fixed to case shot	5 ,,	12	24	84 ,,	1 7¼	,, 11½	1 2½	9 c
2-pr.	Case	2 4	60	26	161 ,,	2 3	1 2½	,, 7¾	33
1½-pr.	Case	1 12½	50	19	108 1	2 ,,	1 1	,, 7¼	34
1-pr.	Case	1 8	50	15	90 ,,	1 9¾	,, 11¾	,, 8¾	35
	Round, strapped	1 1	50	15	68 2	1 ,,	1 ,,	,, 9	36
13-in.	Shells	192 2	1	29	221 2	1 3¾	1 3½	1 4	37
	Carcasses, round	210 ,,	1		239 ,,	1 3¾	1 3½	1 4	
10-in.	Shells	85 3	2	26	196 6	1 10¾	1 0½	1 1	38
	Carcasses, round	98 2½	2		222 5				
	Case, shot	85 6	2		204 12				
	Carcasses, oblong		2	34		1 10¾	1 0½	,, 6½	39
	Light-balls	76 8	2		187 ,,				
Bursters.	15 oz.	,, 15½	36		49 10				
	10	,, 10½	48		52 8				
	7½	,, 8	60		51 ,,				
	7	,, 7½	60		49 2				
	6	,, 6½	60	21	45 6	1 8¼	,, 11	1 0¾	13 c
	5	,, 5½	72		45 12				
	4½	,, 5	72		43 8				
	3½	,, 4	96		45 ,,				
	2½	,, 3	120		43 8				

* S.S. Sea Service. † L.S. Land Service.

In estimating stowage for the above, an allowance must be made, in addition to the length, of $2\frac{1}{2}$ inches, for the two cleats at the ends, through which the rope handles are fixed.

The cartridge boxes which are marked C are made with copper nails.

Memorandum.—For Sieges, the powder is occasionally sent as above, but far more generally in barrels.

Sea Service Magazine Boxes, lined with tinned copper.

		Length. ft.	in.	Breadth. ft.	in.	Depth. ft.	in.	Weight. Empty. lbs.	Weight. Filled. lbs.
Correspond to 1, $\frac{1}{2}$, and $\frac{1}{4}$ powder barrels in contents.	Whole boxes	1	$4\frac{3}{4}$	1	$4\frac{3}{4}$	1	9	$46\frac{1}{4}$	$136\frac{1}{4}$
	Half do.	1	$1\frac{1}{2}$	1	$1\frac{1}{2}$	1	$4\frac{5}{8}$	29	74
	Quarter do.	0	$10\frac{1}{8}$	0	$10\frac{1}{8}$	1	$1\frac{3}{4}$	$17\frac{1}{2}$	40

The powder usually packed in these cases is made up in flannel cartridges, and marked for their respective ordnance: when not thus definitely allotted, it is packed in bags of 15 lbs., of which the whole box contains 6, or 90 lbs.

Small-Arm Ammunition.

		Powder Drs.	Balls per lb.
	Wall piece	10	7
Percussion	Musket-ball-cartridge for muskets of all patterns,—Guards, Line, Line Serjeants, or Navy	$4\frac{1}{2}$	$14\frac{1}{2}$
	Rifle, and Guards Serjeants' rifled musket	$2\frac{1}{2}$	$12\frac{1}{2}$*
	Rifle,—Navy, heavy	$3\frac{1}{2}$	8 nearly.
	Carbine,—Victoria, Ordnance Corps, and Cape Corps 2 bar[d].	$3\frac{1}{2}$	$14\frac{1}{2}$
	Carbine,—Constabulary	$2\frac{1}{2}$	$14\frac{1}{2}$
	Pistol, Navy	2	34
	Pistol, as partially retained in the Cavalry, heavy	$3\frac{1}{2}$	$14\frac{1}{2}$
	Pistol, as partially retained in the Cavalry, light	3	20
	Blank cartridge for all	,,	$3\frac{1}{2}$

The nipple and cap are the same for all Arms; five caps are supplied for every four cartridges; rifles are loaded with a blank cartridge, ball, and grease-patch.

Rifle ammunition, in dark green paper; ball-cartridge, in white; and blank, in blue.

Ball-cartridge Box for the Field Service Ball-cartridge Waggon.

		Cartridges.	Percussion caps.	Weight, filled. lbs.	Exterior dimensions.	ft.	in.	
Percussion	Musket	1000	1250	106	Length	1	$3\frac{1}{2}$	Weight empty, 13 lbs.
	Rifle	1080	1350	$115\frac{1}{4}$	Breadth	0	$7\frac{3}{4}$	
	Victoria carbine	1190	1487	115	Depth	1	$5\frac{3}{4}$	

The ball-cartridge box has only one cleat, $\frac{3}{4}$ inch thick, and it is on the bottom; in estimating stowage for this box, therefore, the allowance must be made in addition to the depth.

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* The *bore* is for $14\frac{1}{2}$; but the belt on the ball gives the additional weight. As taken from actual measurement, the $14\frac{1}{2}$-bore is ·75 in., and the diameter of the ball ·68 in.

ANEMOMETER (*Wind Measure*), Wind Gauge.*

It is not intended to do more in this article than describe some ordinary instruments and modes of observation, in such a manner, that an Officer, wherever his duties carry him, may be enabled to render useful service. The general phenomena of winds, and the place they bear in meteorological science, must be sought in works more exclusively devoted to the subject. It may, however, be briefly stated, that we are to consider wind as the movement of the aerial ocean which envelopes our globe, subject to the laws of fluid matter, and acted on by physical causes, which, though extremely variable, are all more or less reducible to fixed laws.

The most influential cause of aerial currents is change in the density of the air, from changes of temperature. Some of the currents so produced are general, as the trade-winds in the tropical, and their counter-currents in the temperate regions of the globe, with the various translations and oscillations to which they give rise; some local, as land and sea breezes: these latter, indeed, sometimes possess a very extensive character, and embrace a considerable range, as the monsoons of the Indian Ocean. The quantity and tension of aqueous vapour is also very important, from its influence on the density and pressure of the air; and the electrical condition of the atmosphere is well known as a fertile, and often terrific cause of wind. The theory of Hurricanes still requires much observation, before philosophers can determine to what cause the phenomena of revolving gales are really attributable. It is not improbable that the general aerial waves may revolve around nodal points as those of the ocean do. It is also very important to notice whether a gale begins to windward or to leeward, *i. e.* whether the air is propelled, or whether it is sucked into a vacuum.

These are merely indications of the objects to be considered. By such considerations, and others which will readily occur to the intelligent observer, he will arrange his instruments and observations with a view to the peculiar circumstances of his position, so as to afford the class of information which may best elucidate the changes shewn by his anemometer.

The elementary facts we require to know in relation to the wind, are its *direction*, and its *force*, or *velocity*.

The *direction* of the wind is measured by the ordinary vane, and may be read either by direct observation, or by the vane being made to move the hands of a dial. There is an instrument for this purpose called an Anemoscope. The notation commonly used is that of the seaman's compass, but it is sometimes written in degrees of a circle. On this system N. 30° E., for example, means 30° to the eastward of north. The following Table is from Riddell's 'Magnetic Instructions,' p. 131.

Direction.		Corresponding Azimuths.					Direction.		Corresponding Azimuths.				
N.	=	0	0	..	360°	0′	S.S.W.	=	202°	30′	..	157°	30′
N.N.E.	=	22°	30′	..	337	30	S.W.	=	225	0	..	135	0
N.E.	=	45	0	..	315	0	W.S.W.	=	247	30	..	112	30
E.N.E.	=	67	30	..	292	30	W.	=	270	0	..	90	0
E.	=	90	0	..	270	0	W.N.W.	=	292	30	..	67	30
E.S.E.	=	112	30	..	247	30	N.W.	=	315	0	..	45	0
S.E.	=	135	0	..	225	0	N.N.W.	=	337	30	..	22	30
S.S.E.	=	157	30	..	202	30	N.	=	360	0	..	0	0
S.	=	180	0	..	180	0							

* By Major Larcom, R.E.

The *force* of the wind is estimated by its pressure on a given surface, usually the pressure per square foot. Various instruments have been devised for measuring it directly; as, for example, by connecting with a board a foot square some simple apparatus moving a weight over a pulley; or a spring whose strength has been estimated; and the indications of these instruments, as well as those last described, may be read on a dial. So, also, by the revolutions of a set of wind-mill vanes, weights or counterpoises may be moved, or balls projected outwards on a slide, by the centrifugal force communicated to a vertical spindle,—or, like the well-known regulator of motion in machines, called a 'governor.' Any of these, if kept in good order and carefully observed, will furnish useful indications. There is one differing from these, but so simple and portable that it may be worth while to describe it. LIND's *Anemometer* (Plate I. fig. 1) is a bent tube of glass, to be half filled with water, of which the neck or bent portion is very narrow, in order to check the motion of the water. As they are made in the shops, the vertical parts of the tube are 8 inches, and $\frac{1}{4}$th of an inch in diameter. A scale is fixed between them, graduated in inches and tenths. One tube has a brass cap (*a*) turned at right angles, and open; this orifice is kept facing the wind by a vane (*b*), the whole swinging by swivels on an axis, which may be fixed on any staff or other support. The other tube also terminates in a brass cap (*c*), having only a small hole in it to admit air. Water is poured in till it stands at the zero of graduation in both tubes. When the orifice is now presented to the wind, the water is of course forced down in the one tube, and rises in the other. The difference shewn by the scale will be the height of a column of water whose weight is equal to the force of the wind. And, as a cubic foot of water weighs 1000 ounces, a stratum of water of a foot square, and 1 inch deep, will weigh $\frac{1}{12}$th of 1000 ounces, or $5\frac{1}{5}$ lbs. nearly, which is obviously the pressure of an inch of water on a square foot of surface. A rise, therefore, of 1 inch in the tube of this instrument indicates a pressure of $5\frac{1}{5}$ lbs. in the square foot, which is the force of the wind at that time, and so on.

The *velocity* of the wind may be measured directly, or it may be deduced from its force. Rough indications of velocity may be obtained by merely noticing the shadows of clouds, or by the flight of balloons, but these all give obviously the currents only of the upper air, and belonged to the infancy of science. A very simple contrivance has been used by Sir Wm. Snow Harris, which he thus describes: "A cork, stuck round with capacious feathers, is made to travel over a fine wire of a given length by the force of the wind. The cork is set on a common writing quill, bushed with a small brass plate at each end, by which the whole is supported on the wire, fine holes being drilled through the brass plates for receiving it. This contrivance is extremely light, and will fly along the wire with the velocity of the wind, or very nearly so, for a given distance. It is in fact throwing, as it were, a log-line on the air."

Or, the velocity may be deduced from the force, for which purpose a series of experiments was made at Woolwich by Dr. Hutton, who, as might be expected, found the force nearly proportional to the square of the velocity, being of course the same as that opposed to a body moving through a medium, the only difference being, that in this case the body is at rest and the air in motion. By those experiments he found a velocity of 20 feet per second equal to a pressure of 12 ounces on a square foot, from which he deduced a Table for Dr. Lind's Anemometer, which has been subsequently corrected by Mr. George Harvey, from whose paper in the 'Encyclopædia Metropolitana' it is here copied, with some extensions.

Table shewing the Force and Velocity of the Wind, &c.

Height of the Column of Water.	Force of the Wind on a square foot.	Velocity of the Wind per hour.	Common designation of such a Wind.
In Inches and Decimals.	In Avoirdupois Pounds.	In Miles and Decimals.	
0·05	0·26	8·0	A pleasant wind (light breeze).
·10	0·52	11·3	A fresh breeze.
·15	0·78	13·9	
·20	1·04	16·0	
·25	1·30	17·9	
·30	1·56	19·6	
·35	1·82	21·7	
·40	2·08	22·7	
·45	2·34	24·1	
·50	2·60	25·4	A brisk gale.
·55	2·86	26·6	
·60	3·12	27·8	
·65	3·38	28·9	
·70	3·64	30·0	
·75	3·90	31·1	
·80	4·16	32·1	
·85	4·43	33·1	
·90	4·69	34·1	
·95	4·94	35·0	
1·00	5·21	35·9	A high wind.
1·50	7·81	44·0	
2·00	10·42	50·8	A very high wind.
2·50	13·02	56·8	
3·00	15·62	62·2	A storm.
3·50	18·22	67·2	
4·00	20·83	71·8	A great storm.
4·50	23·43	76·2	
5·00	26·04	80·4	A very great storm.
5·50	28·89	84·6	
6·00	31·75	88·7	A hurricane.
6·50	34·15	92·0	
7·00	36·55	95·2	A great hurricane.
7·50	39·10	98·5	
8·00	41·66	101·6	A very great hurricane.
9·00	46·87	108·0	Most violent hurricane.
10·00	52·08	113·6	Most violent hurricane.
11·00	57·29	119·2	Most violent hurricane.
12·00	62·5	124·0	

In violent winds a heavier fluid, even mercury, may be used; or, in great degrees of cold, a saturated solution of sea salt has been recommended. In either case the figures which denote the force in the above Table must be multiplied by the specific gravity of the fluid employed.*

But our knowledge of the aerial currents would have made very slender advances from individual observations alone, however numerous, and much ingenuity has accordingly been exerted in the contrivance of self-registering instruments. The two which at present divide the opinion of philosophers are those invented by Dr. Whewell in 1835, and Mr. Osler in 1836.

* On one of the mountain stations of the Trigonometrical Survey of Ireland, 2469 feet above the sea, the water was completely blown out of Lind's anemometer; the force, therefore, amounted to 41·7 in the square foot, and the velocity 101 miles an hour, at the moment the whole of the water was driven into and sustained in the further leg, after which it must have increased considerably, though it had escaped beyond the limits of the instrument to measure.

The object of the former is thus stated by the inventor: "To obtain a record of the total *amount* of the aerial current which passes the place of observation in each direction. The assemblage of such records for any given time will exhibit a *type* of the course of the wind for such time; the mean of such records at the same place, for different years, will exhibit the *annual types* of the winds for that place; and the comparison of the types of the winds for many different places will throw light upon the general annual movement of the atmosphere." It is thus described: "It consists of a small wind-wheel, like a wind-mill with eight sails,* which is kept towards the wind by a vane. The rapid rotation of this wheel is by a train of toothed wheels and screws, converted into a slow vertical motion, one-twentieth of an inch being the descent produced by 10,000 revolutions of the wheel, which motion carries a pencil downwards, tracing a line on the surface of a vertical cylinder, having the axis of the vane for its axis. The extent of vertical motion shews the amount of the wind, and the part of the circumference of the cylinder, on which the trace lies, shews the direction."

This will readily be understood by inspection of fig. 2, Plate I., which exhibits an instrument of this kind, erected at the Ordnance Survey Office, near Dublin, together with figs. 3 to 14, Plates I. and II., which shew the details of construction, as given by Sir Wm. Snow Harris, in the 'Transactions of the British Association for 1842.' In the Dublin instrument, instead of the pencil marking the course on the cylinder itself, to be rubbed off every time the pencil reaches the bottom, there is a paper ruled exactly like the cylinder, lapped around it, and pasted together at the edges. When the pencil has descended to the bottom, the paper is replaced by a new one. A series of such papers, afterwards joined into one length, forms an actual field-book, as it were, of the wind for any length of time.

In order to determine the absolute velocity of the aerial current from this instrument, a series of experiments was made by Sir Wm. Snow Harris, from which he arrived at the following deductions:

1st. "When the pencil tracing the integral effect of the wind moved by the revolutions of the fly at the rate of one division of the scale of measure, or ·1 of an inch per hour, the current of air for the same time moved at a mean rate of 11 feet per second."

2nd. "The space described by the pencil appeared to be proportional to the square of the velocity of the aerial current acting on the fly. Thus, when the pencil described four divisions of the scale in an hour, the velocity, by a mean of many observations, amounted to 22 feet in a second. When the velocity was 15 feet in a second, the pencil had described about two divisions of the scale in an hour, and so on. Having, then, the velocity due to a given rate of indication per hour taken as unity, it is easy to find the velocity due to any other rate of indication, since we have only to multiply the square root of the given rate by the constant 11, the velocity per second corresponding to a space of one division of the scale."

By this rule, the mean velocity of wind, as indicated by this instrument at Plymouth, between April, 1841, and April, 1842, was 13·16 feet per second, or about 9 miles per hour. The actual velocity being thus obtained, the force may be deduced from it by Hutton's Table, p. 37. But if the descent of the pencil be proportional to the square of the velocity, it is of course at once a measure of the force without the intervention of velocity. These deductions must, however, be received with great caution, because it is obvious the descent of the pencil ought to be *directly* proportional to the velocity, and it can only be rendered otherwise by friction, an element so variable, that separate experiments are necessary for every individual instrument.

Osler's Anemometer is thus described by its inventor. "*The direction* of the wind

* No specific direction for the sails is given. The best would appear to be about 55°, the maximum angle for the sails of a wind-mill.

is obtained by means of the vane attached to the rod, or rather tube, which carries it, and consequently causes the latter to move with itself. At the lower extremity of this tube is a small pinion, working in a rack, which slides backwards and forwards as the wind moves the vane, and to this rack a pencil is attached, which marks the direction of the wind on a paper ruled with the cardinal points, and so adjusted as to progress at the rate of an inch per hour, by means of a clock. The force is at the same time ascertained by a plate one foot square, placed at right angles to the vane, supported by two light bars running on friction rollers, and communicating with three spiral springs in such a way that the plate cannot be affected by the wind's pressure without instantly acting on this spring, and communicating the quantum of its action by a light wire passing down the centre of the tube to another pencil below, which thus registers its degree of force."

This instrument also has attached to it an additional apparatus for registering the rain.

In the Meteorological Instructions recently published by the Royal Society especial attention is directed to the following points regarding wind:

1st. "Its average intensity and general direction during the several portions of the day devoted to observation."

2ndly. "The hours of the day or night when it commences to blow from a calm, or subsides into one from a breeze."

3rdly. "The hours at which any remarkable changes of its direction take place."

4thly. "The course which it takes in veering, and the quarter in which it ultimately settles."

5thly. "The usual course of periodical winds, or such as remarkably prevail during certain seasons, with the law of their diurnal progress, both as to direction and intensity; at what hours, and by what degrees they commence, attain their maximum, and subside; and through what points of the compass they run in so doing."

6thly. "The existence of crossing currents at different heights in the atmosphere, as indicated by the courses of the clouds in different strata."

7thly. "The times of setting-in of remarkably hot or cold winds, the quarters from which they come, and their courses, as connected with the progressive changes in their temperature."

8thly. "The connection of rainy, cloudy, or fair weather, with the quarter from which the wind blows, or has blown for some time previously."

A few words may be necessary on the modes of reducing and digesting the recorded results of an anemometer, though none have been finally determined as applicable to all. The observations of Dr. Whewell's instrument are reduced in a particular manner for the purpose of ascertaining the *integral effect* of the wind, *i.e.* the amount and direction of aerial fluid which finally proves to have passed over the place of observation at the end of a year, or any other period. First, by resolving each partial wind into its component parts E. and W. and N. and S.; then from the sum of all the W. components, subtracting the E. elements, which gives the effective W. winds; and from the sum of all the S. components, subtracting the N. elements, which gives the effective south winds. The magnitude and proportion of these two effective winds compounded give the magnitude and direction of the *effective wind*, or amount of air which has been *on the whole* transferred across the place of observation during the whole term of observation. This reduction is performed by considering each wind as the hypothenuse of a right-angled triangle, and finding the natural sine and cosine of each, which, used as multipliers, will give its value in the required direction. Thus the four inter-cardinal winds, N.E., &c., are reduced to the cardinal directions by multiplying by $\frac{7}{10}$. The eight subordinate winds, N.N.E., &c., have for multipliers

$\frac{12}{13}$ and $\frac{4}{10}$. Thus a wind N.N.E. 65 is equivalent to N. 60 and E. 26. The oblique winds have for their multipliers $\frac{2}{10}$ and $\frac{98}{100}$; and for the remaining points $\frac{55}{100}$ and $\frac{83}{100}$ may be used, but such minuteness can seldom be necessary.

Indications of Whewell's Anenometer.

JANUARY, 1837.

1	N. 12	Total. 12	12	N. N.E. 2 0	Total. 2	22	S.S.E. 45	Total. 45
*2	N.N.W. S.W. 8 1	9	*13	S.S.W. S.W. 45 9	54	*23	S. S.S.W. 22 34	56
3	W. 7	7	14	S.W. N.W. 11 58	69	24	S.S.W. S.W. 44 10	54
4	S.W. 11	11	*15	N.N.W. 56	56	25	S.W. E. 7 8	15
5	S.W. 11	11	16	N.N.W. W.S.W. 7 2	9	*26	E.N.E. 44	44
6	S.S.W. 28	28	17	S.W. W.N.W. 2 1	3	27	E.N.E. 65	65
*7	S.W. 51	51	18	N.W. 0	0	*28	E.N.E. 48	48
8	W.S.W. 29	29	19	E.N.E. 0	0	29	N.E. 34	34
9	S.S.W. 26	26	20	E.N.E. 12	12	30	E.N.E. S.E. 10 15	25
*10	S.S.W. 76	76	21	S.S.E. 6	6	*31	S.S.E. 48	48
11	S.W. N. W.N.W. 13 25 4	42						

FEBRUARY.

1	S.S.E. S. S.S.E. 5 5 8	Total. 18						
2	S. 2	2						
3	S.E. 14	14						
4	S.E. 30	30						
5	S.E. S.S.E. 17 10	27						
6	S.S.E. 29	29						
7	S.S.E. S. 31 7	38						

* The asterisk indicates the times when the instrument was wound up.

Reduction of the Indications of the Anemometer.—1837.

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	N.
Jan. 1 to 14.	12		0							28	1	29	7	4		8	
1 14	25									26	11						
N. S.W.	2									76	11						
12 11										45	51						
											13						
											9						
											11						
	39									175	107	29	7	4		8	
S.S.W.									162				70				
S.W.									75				75				
W.S.W.									12				27				
W.N.W.	1												4				
N.N.W.	7												2				
	47								249			W.	185				
								N.	47								
								S.	202								
Jan. 14 to 20.				12							2	2		1	58	56	
14 20																7	
N.W. E.N.E.				12							2	2		1	58	63	
58 12																	
E.N.E.	5				11				1				1				
S.W.									0				2				
W.S.W.													1				
W.N.W.	0												41				
N.W.	41												25				
N.N.W.	58																
													70				
	104											E.	11				
S.	1																
												W.	59				
N.	103																
Jan. 21 to 25.								6	22	34	10						
21 25								45		44	7						
S.S.E. S.W.								51	22	78	17						
6 7																	
S.S.E.					20												
S.S.W.									47				31				
W.S.W.									72				16				
									7				47				
								S.	148			E.	20				
												W.	27				
Jan. 26 to 30.			34	44	8												
25 30				65													
E. E.N.E.				48													
8 10				10													
			34	167	8												
N.E.	24				24												
E.N.E.	65				154												
N.	89			E.	186												
Jan.30—Feb.7.							15	48	5								
S.E. S.							14	5	2								
15 7							30	8	7								
							17	10									
								29									
								31									
							76	131	14								
S.E.					53				53								
S.S.E.					52				121								
					105			S.	188								

Summary.

	N.	E.	S.	W.
Jan. 1 to 14 . .	. . .	. . .	202	185
,, 14 ,, 20 . .	103	. . .	. . .	59
,, 21 ,, 25 . .	. . .	. . .	148	27
,, 26 ,, 30 . .	89	186	. . .	. . .
,, 30 ,, Feb. 7 .	. . .	105	188	. . .
	192	291	538	271
			192	291
			S. 346	E. 20

Various modes have been devised of exhibiting graphically the results of wind observations. The most simple is to plot the course like a traversed survey; *i. e.* starting from a given point, draw a line in the direction of the first recorded wind, of such a length as represents its magnitude. From the extremity of this line draw another, representing the direction and magnitude of the second recorded wind, and so on; or, lines may be drawn radiating from a centre to all the points of the compass; each line being made of length proportioned to the magnitude it records, whether of prevalence or of force. The extremities of the lines being joined, a polygon is formed, it may be for a month. The comparison of polygons formed from several recurrences of the same month will give a type of that month, and their combination a type of the year. The same may be expressed by curves formed from ordinates and abscissæ, or in various ways suitable to particular purposes, which it is not necessary to dwell on.

There is one mode, however, so ingenious that it deserves especial mention. It is that devised by M. Léon Lalanne for exhibiting three variables. It will easily be understood by considering that we can fix any point on a plane by the intersection of two co-ordinates; and if we suppose each of these co-ordinates to represent a variable, and a perpendicular to be erected on that point, of such a length as shall represent the third, we shall have a net-work of squares, and from every intersection a perpendicular projecting upwards: the summits of these perpendiculars, varying in length, will represent, as it were, the surface of a model of ground. But the difficulty remains of exhibiting on the plane of the base the position which the summit of the perpendicular occupies in space. This difficulty, however, is precisely the same as that felt in representing the undulations of ground in a plan; and the application of contours, so successful in the latter, is equally descriptive in the former. Suppose we desire to exhibit the prevalence of particular winds at particular places for each month of the year; say at Dum Dum, near Calcutta. (Plate III. fig. 15.) [This is the example given by M. Lalanne.] The winds range up the sides of the rectangle, the months at its top and bottom; the imaginary lines perpendicular to the plane indicate the proportional prevalence of the winds in each month, their height being represented by figures of altitude, and all those which are equal being joined to form the curves, or contours. In this figure M. Lalanne has chosen to divide the month into twentieths. Following now the vertical line which indicates the month of September, for instance, till we come to the horizontal line marked East, we find ourselves on a contour marked 4, which indicates that during $\frac{4}{20}$ or ·2 of the month of September the wind was easterly, and so on. A curve constructed of abscissæ and ordinates in the usual way would obviously be analogous to *a section* of the ground of which the figure of M. Lalanne may be considered for the moment as a topographic representation, but a separate curve must be made for each month to afford the same information.

In like manner the polygons before mentioned might, by constructing one for each month, be made to represent the same thing. (Plate III. fig. 17.) This latter, indeed, is analogous to a topographic projection on polar co-ordinates, but either of these modes would obviously be far more complicated, and less graphic, than this most ingenious contrivance, which is, besides, susceptible of various other applications and extensions.

Since this article was written, very extensive observations have been carried on, and their results published, more especially those of the Colonial Observatories, where the relation to, and connection of the wind with, other meteorological phenomena, give them a peculiar and practical value. These are to be found in great detail in the several publications devoted to them.

At the Ordnance Survey Office, near Dublin, improvements have been effected in the self-acting portion of Whewell's anemometer, by which the time also is now recorded in conjunction with the direction and velocity.

A valuable instrument has also been introduced by the Rev. Dr. Robinson, of Armagh, which combines great strength and simplicity with other advantages. It has been brought into use in various observatories and public establishments: among others, one is now in process of erection on the west pier of the Royal Harbour of Kingstown.

Dr. Robinson attaches peculiar importance to the direct observation of velocity—rather than inferring it from records of pressure, and sums up his objections to the existing instruments as follows:

"First, wind fluctuates, both in velocity and direction, to an extent of which I had no conception till I entered on these researches. Instead of being a uniform flow of air, it may be likened to an assemblage of filaments moving with very unequal speed, and contorted in every direction; being, in fact, analogous to a river in flood, but with its eddies and counter-currents considerably exaggerated.

"Now, assuming the common equation $V^2 = mP$, we find $\frac{2dV}{V} = \frac{dP}{P}$, or the *relative* variations of pressure are twice as great as those of velocity; a record of the latter will, therefore, be far less irregular.

"But the evil goes further; for in the fluctuations both of pressure and direction the inertia of the moving parts of the anemometer carries them far beyond the point of balance, and makes the measure of pressure inaccurate, partly by exaggerating the amount of its changes, partly by the surface which receives the wind's impulse being at times wrongly placed with respect to its direction. The magnitude of this cause of error may be appreciated from these two facts, that I have seen Lind's (the only pressure-gauge which I possess) range in a few seconds from 0 to 2·6 inches; and that in some winds a free vane will oscillate through arcs of 120°."

These reasons he deems sufficient for absolutely rejecting the pressure-gauge, and adopting instead of it one which gives directly the velocity, or rather its equivalent, the space traversed in a given time. After describing various attempts which have been made in this direction with more or less success, he gives the preference to an instrument suggested to him many years ago by the late Mr. Edgeworth;—it is a horizontal wind-mill whose vanes are hollow hemispheres, their diameters coinciding with the arms that support them; the action on their concave surfaces exceeding that on the convex so much, that the machine is capable of being used as a motive power with considerable advantage. Its simplicity of form is such, that without very great exactness of workmanship, similarity of action can be attained; and it combines great lightness with strength sufficient to resist very severe gales.

This instrument the Doctor has adopted and improved: in order to ascertain the relation between the velocity of the vanes with that of the wind, he instituted nume-

rous experiments, which, with the mathematical demonstrations connected with them, are ably detailed in the 22nd vol. of the 'Transactions of the Royal Irish Academy.'— On the whole, he concludes that we are warranted in laying down as a law, that in a horizontal wind-mill of this description *the centres of the hemispheres move with one-third of the wind's velocity, except so far as they are retarded by friction.*

This principle once established, its application is easy. Fig. 1, Plate IV., shews the external appearance of the anemometer at Armagh, as it stands on the flat roof of the dwelling-house.

Its frame consists of four uprights, 3 inches by 2 inches, and 15 feet 4 inches long; 6 feet 5 inches asunder below, 2 feet 4 inches above: they support the strong frame B, in which a diagonal carries the bearings of the axles C and D; the part H is sheathed and roofed with plank (the roof covered with painted canvas), and it forms a very convenient room for the self-registering apparatus. The copper funnel F is attached to each axle, to prevent the entrance of wet. The great height of this frame is necessary to clear the dome of the west equatorial, which rises S. E. of it; but it has the double disadvantage of causing additional friction by the weight of the long axles, and making the whole less stable: to obviate this last defect, about 3 cwt. of pig ballast is disposed round the floor of H, notwithstanding which, the machine was blown down in March 1845. After this it was further secured by three iron shrouds attached to the walls in the directions S. E., S. W., and N. W.; and it has since withstood still heavier gales. The axle C bears the mill G for space; the axle D, the vane V, for direction.

The dimensions are, 12 inches for the diameter of the hemispheres, and 23 inches for the distance of their centres from that of the axle. The hemispheres are made of sheet zinc, strengthened by a wire rim; each weighs 1·31 lb., but might have been lighter if made of thin copper. The arms which carry them are iron, 1·5 inch broad and 0·1 thick, but feathered off to a sharp edge at each side, and kept from bending downwards by stays of wire. The hemispheres are four; this number having by experiment proved better than either five or three;—six appeared inferior to any lower number, not excepting two; probably because some eddy from the concaves reaches the convex surfaces. The iron tubes T, 8 and 18·5 inches long, are secured to the diagonal of the top frame, and carry boxes of bronze in which are bronze balls, on and between which the axles C and D turn.

The direction vane V is 3 feet long by 1½ foot extreme breadth; it also is made of sheet zinc. From a wish to give it as little momentum as possible, it was at first a light wooden frame covered with varnished calico, which the wind soon destroyed. This axle turns also on balls.

It remains to describe the self-registering apparatus:

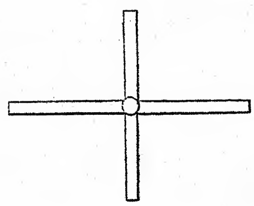
First, as to the space; the dimensions given above for the wind-mill are such that in 440 revolutions the hemispheres travel 1 mile, and the wind 3 miles. If degrees on the paper be miles of wind, the number of the former must be 440×120 for one of the paper-holder. The train, which effects this very simply, is shewn in Plate IV. fig. 5, where A is an arbor held loosely in the lower extremity of the axle, and carried round with it by the screw C; an endless screw on this drives the wheel B, of 88 teeth; a second endless screw, S, drives C, of 100; its pinion D, of 16, drives E, of 96: on this the brass plate P, 14 inches in diameter, is fastened by a steady-pin and the nut H, which also assists in holding down the paper. The speed of the train is therefore $= 88 \times 100 \times 6 = 440 \times 120$.

The arrangement for direction is shewn in Plate IV. fig. 6. The arbor F (which is also loose in the hollow of the vane-axle) bears the wheel G, of 96, which drives K, of 96. On this the paper-holder P′ is secured by H′; its angular movement is therefore equal

to that of the vane, while the paper can be more easily removed than if it were immediately carried by the vane-axle.

That axle is connected with the arbor F, not by any rigid attachment, but by the spiral spring L. This is necessary, not merely to prevent the destruction of the machinery in violent oscillations of the vanes, but still more to lessen their extent on the register paper. It must however be remembered, that they cannot be avoided entirely, nor is it desirable that they should be too much diminished; for this is a distinctive character of some winds, independent of their velocity, and therefore implies some peculiarity in the origin or progress of the current. In particular, when excessive, it is connected with a roaring sound that gives an exaggerated impression of their force. This was strikingly exemplified in the destructive tempest of February 1850, whose highest velocity did not exceed forty miles per hour. On another occasion, when the velocity was of nearly the same amount, the sudden diminution of roar led to a supposition that the gale was abating; but on going to the instrument it was found that the velocity had increased to 52, while the range of direction was only half its previous extent.

A still further check to the direction-fluctuations was applied by making the wheel G drive a regulator attached to the arbor of the pinion I, but not shewn in the drawing. This consists of four vanes, as shewn in the margin, made of light deal frames covered with paper. Each is 37 inches high and 15 inches broad. As the whole is very light and turns on an agate, it yields to the slightest impulse of the vane, *if time be given*, but presents a very great resistance to rapid motion. Its speed is $\frac{26}{10}$ times that of the vane, and this, combined with the action of the spring, will often reduce the oscillations to one-third of their absolute magnitude. As at first applied, this regulator was much smaller and immersed in water; but that plan was abandoned in consequence of its action being interrupted during frost.



Lastly, Plate IV., fig. 3, shews the method of connecting these two registers with that of time. N is a cast-iron plate which bears the whole machinery, 40 inches by 14 inches. P and P′ are the paper-holders; each has three spring-clips at its circumference, to hold the paper, which is further secured by the screw H, passing through a hole punched in its centre; this screw serves also to centre it, being of the same size as one of its circles. One of these clips bears a fiducial line, with which the zero of graduation is made to coincide when a new paper is applied. M is a common clock movement, the weight and pendulum of which pass through openings in N: its barrel carries a second wheel, which moves, by a rack, the bar $p\,p'$ through six inches in twelve hours. This bar slides in a dovetail on the front plate, and carries adjustable tubes at its extremities, in which pencil-holders are placed, and made to act by weights placed in their cups. Since, however, in the direction-register, the pencil, as at first arranged, and shewn in the figures, travels from the circumference, it occasionally has pulled the paper from the clips and torn it. An additional piece, therefore, has lately been added, one end running in a guide at O, the other provided with a stud which fits in p'; this complicates it a little, but remedies the inconvenience, and makes the time-reading the same in both registers.

The paper used is printed in red, from a plate engraved with a graduation of degrees and half-degrees. Within this are a series of concentric circles, which represent portions of time.

Those which correspond to hours are stronger than the rest, and half an inch apart; the intermediates shew decimals of the hour. The mode of using it is this: the pencil p' being removed, the date is written on P near its pencil; the clock is then wound up, and p draws a line from the circumference to the centre. The paper on P′ is then removed or shifted, and if another be placed, it is similarly dated, with the addition of the degree, which is set at the fiducial line; and the pencil p' is replaced. Then, during the ensuing twelve hours, the action of the clock carries the pencils from the centre to the circumference. If there were no wind, they would merely draw radial lines; but in general p traces a spiral, and p' shades an irregular sector. The clock should be adjusted so that the twelve hour-circles should be exactly traversed. In general, a space-paper may contain four or six spirals, dating each winding line; and a direction one, two or three sectors, shifting the zero point for each. This zero, in my practice, represents a wind from the south, and the graduation goes round from west to north. The papers are finally fixed with a weak solution of mastic in spirit, and preserved for reference.

In reducing these diagrams to a form available for computation, no system appeared preferable to the method pointed out by Dr. Whewell in his Memoir. In the first instance, the centres of the papers are restored; in the space-papers, drawing radii through the intersections of the spirals with the hour-circles, the graduation gives the hourly spaces, which, if necessary, are corrected for friction: these are tabulated. In a second column is entered the direction at each hour. This is found by bisecting the arc of the hour-circle, which is shaded by the pencil. The mean direction during each hour will, in general, not differ from the mean of those at its beginning and end; but if the eye perceives that this is not the case, those for the decimals of the hour may be taken. From this are computed two rectangular co-ordinates, which are given in the third and fourth columns; *w* the motion of the wind from the west, *s* that from the south. These are obtained by multiplying the hourly spaces into the sine and cosine of the mean direction.

As an example, the reductions are annexed of the twelve hours during which the centre of the cyclone of March 1850 passed the Observatory, as one which will illustrate the process in an extreme case.

Date.	Space.	Direction.	W.	S.
March 29, 10 P.M.	m.	303°·8	m.	m.
11	33·5	313·8	−26·1	+21·0
12	32·0	320·5	−26·8	+23·4
1 A.M.	31·1	307·3	−22·4	+21·5
2	29·4	314	−22·3	+19·1
3	30·3	294·7	−25·0	+17·1
4	31·5	77·2	−19·9	−24·4
5	30·5	78·8	+29·9	+ 6·3
6	31·1	66·7	+29·7	+ 9·3
7	31·1	69·1	+28·8	+11·7
8	32·9	88·2	+24·5	−22·0
9	36·6	88·2	+33·4	+ 1·0
10	37·5	99·9	+37·5	− 0·3
Sum	385·5		+46·3	+83·7

The means for the two irregular hours are taken from the reading of each tenth. We have $\tan D = \frac{46\cdot3}{83\cdot7}$, which, as both are positive, must be in first quadrant; therefore,

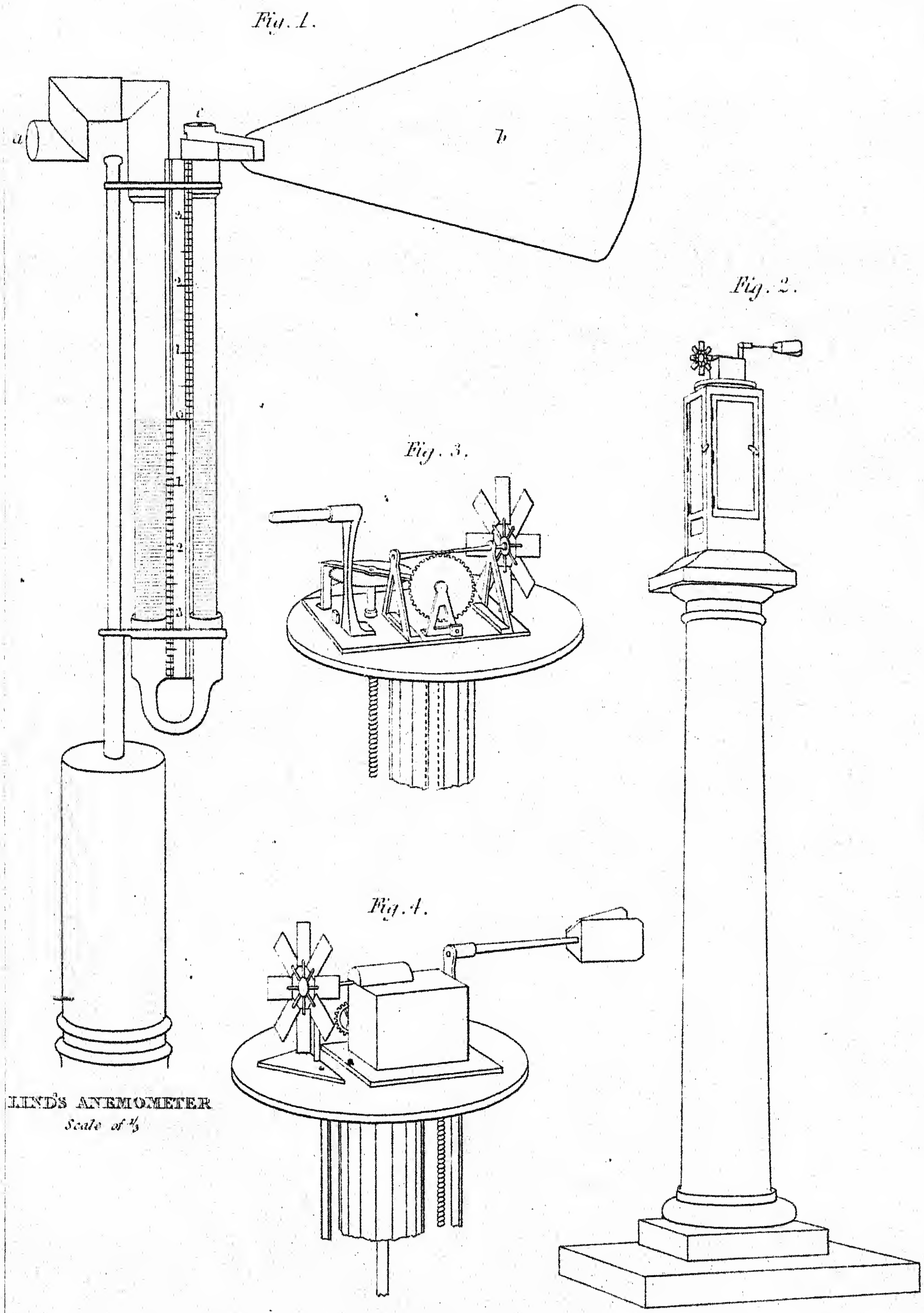


Fig. 1.

LIND'S ANEMOMETER
Scale of 1/3

Fig. 2.

WHEWELL'S ANEMOMETER.
Scale of 1/30

Fig. 3.

Fig. 4.

J. W. Lowry fc.

John Weale, 59, High Holborn, 1845.

Fig. 5.

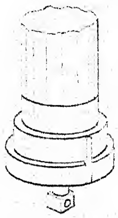


Fig. 6.

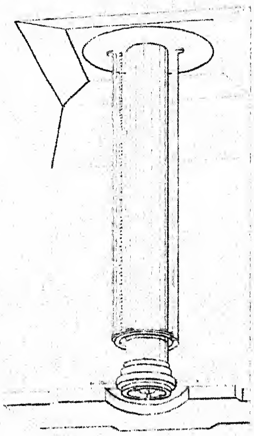


Fig. 7.

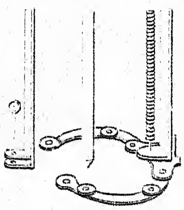


Fig. 8.

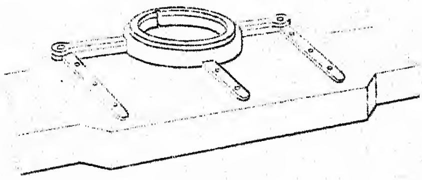


Fig. 9.

Fig. 10.

Fig. 11.

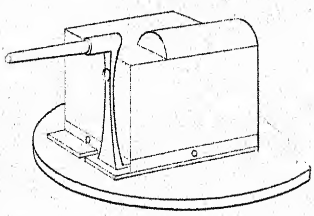
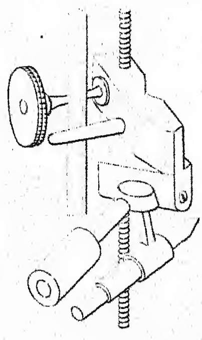


Fig. 12.



J.W. Lowry fc.

John Weale, 59, High Holborn, 1845.

Fig. 13.

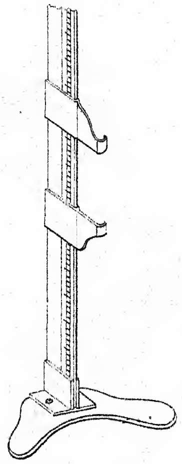


Fig. 15.

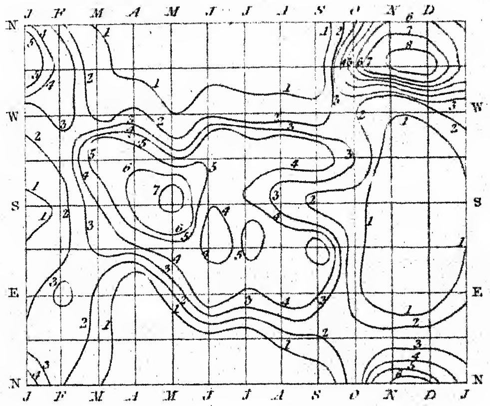


Fig. 16.

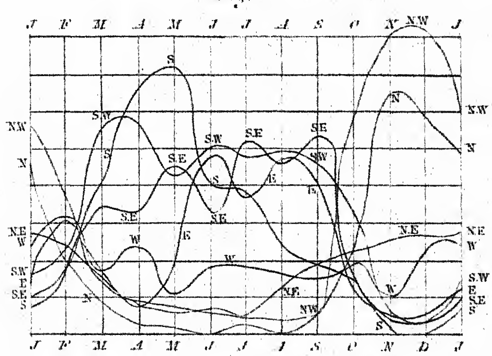


Fig. 14.

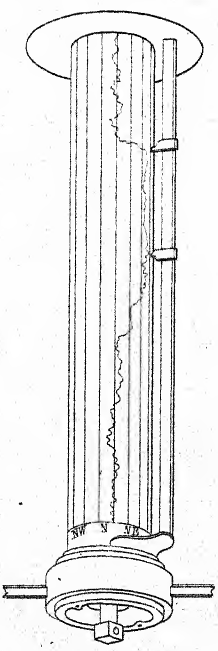
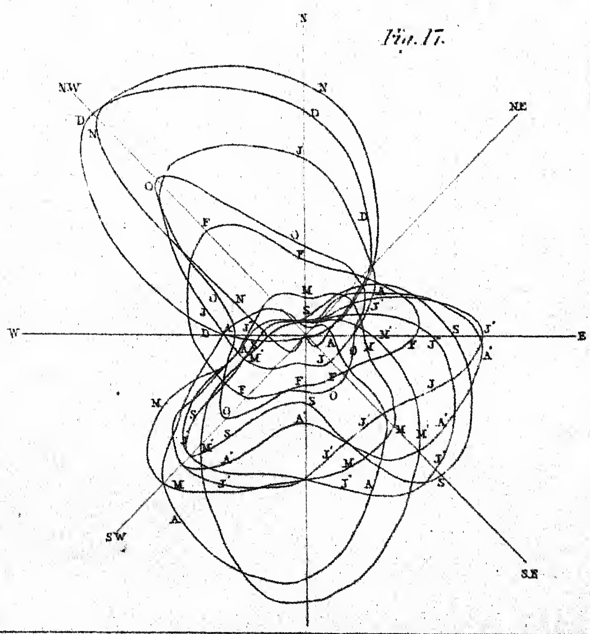
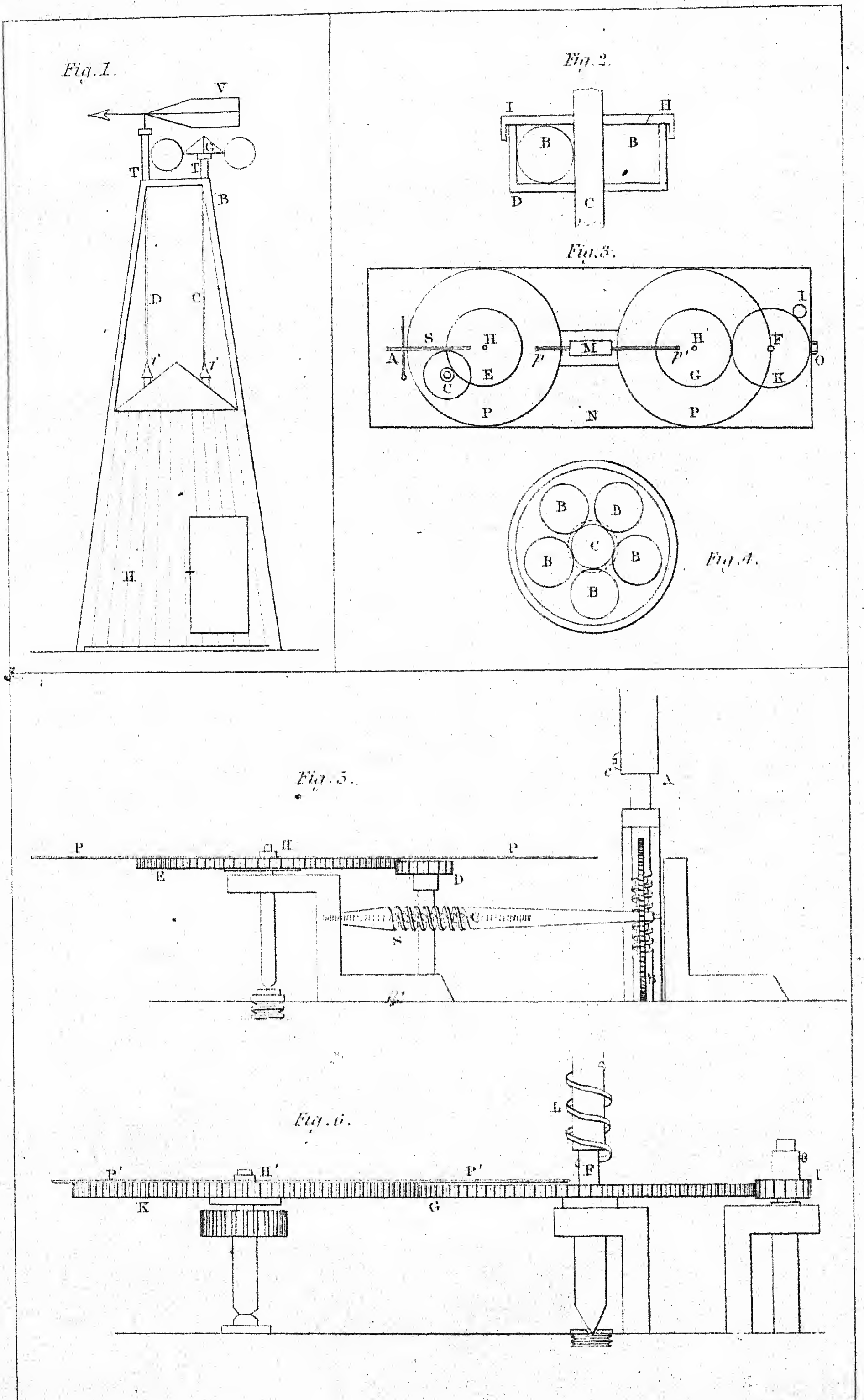


Fig. 17.



J.W. Lowry fc.

John Weale 59 High Holborn 1845.



J.W. Lowry fc.

London, John Weale 59 High Holborn 1852.

$$D = 28^{\circ}\cdot95, \text{ and } \Sigma = \frac{46\cdot3}{\sin 28^{\circ}\cdot57''} = 95\cdot65.$$

It appears, therefore, that during these twelve hours the real movement of the air was only 95·6 miles, from a point 29° west of south.

The paper from which the above account of Dr. Robinson's instrument has been abstracted is probably the best epitome of the present state of Anemometry which can be referred to by persons desirous of pursuing this interesting subject.

T. A. L.

(See article 'Weather,' in the last volume.)

ANTI-CORROSION, as applied to Iron Traversing Platforms, Gun Carriages, and outsides of Guns.

44 oz. anti-corrosion. 4 oz. Grant's black. 2 oz. red-lead. $\frac{1}{4}$ gal. linseed oil. $\frac{1}{16}$ pt. spirits of turpentine.	To be well mixed, and laid on immediately, as it becomes useless from its hardening into a cake.

Anti-corrosion.—Quantities for Ordnance, &c., two coats.

Guns.				Carronades.			Mortars.			Bed.	
pr.	ft.	lbs.	oz.	pr.	lb.	oz.		lbs.	oz.		
32	9½	3	1	32	1	0	13-inch Sea	2	8		
24	9½	2	7	24	0	9½	10 „ „	1	1		
18	9	1	10	18	0	8	13 „ Land	0	12	2	1
							10 „ „	0	9½	1	6
							8 „ „	0	6	1	1

Iron Carriages average 4¾ lbs., and Traversing Platforms 14¼ lbs.

The bores are lacquered with the following:

36 oz. Cumberland black-lead. 1 gal. linseed oil. 10 oz. red-lead. 1 oz. lamp-black.	To be well ground into the oil, and then boiled slowly till thoroughly incorporated.

R. J. N.

ARTILLERY.*—This subject was only undertaken after a distinguished Officer of Artillery had declined to contribute the article; and it is given for the use of the Army in general, and in explanation of the several Tables which have been supplied through the kindness of the Officers of the Artillery Departments.

'Artillery,'—in the British Service, comprehends every branch of that part of the Army, and includes *Matériel*, as well as *Personnel*, besides the constructive and scientific departments.

Marine Artillery, (*Armament of Ships of War*,) and the *Theory of Artillery or Gunnery*, and '*Equipment*,' are explained as they occur alphabetically in separate articles.

* By Major-General Lewis, C.B., R.E.

SECTION I.

The constituent subjects of 'Artillery' may be concisely stated as follows:

- ARTILLERY.
  - Personnel.
    - Horse Artillery.
    - Rocket ditto.
    - Foot ditto.
    - Invalid Gunners.
    - Master Gunners.
  - Matériel..
    - Ordnance ....
      - Iron ....
        - Guns.
        - Howitzers.
        - Mortars.
        - Carronades.
      - Brass ....
        - Field guns.
        - Do. howitzers.
        - Mortars.
      - Rocket.......
        - Field.
        - Heavy.
    - Carriages ....
      - Travelling .....
        - Field.
        - Siege.
      - Standing......
        - Wood.
        - Iron.
      - Waggons, &c.
    - Ammunition ..
      - Powder.
      - Shot.
      - Shells.
      - Case or canister.
      - Grape.
      - Spherical case.
    - Stores in general.
  - Instruction
    - Academical ....
      - Mathematics.
      - Fortification. } Theoretical.
      - Gunnery . . } Theoretical.
      - Languages.
    - Practical ....
      - Fabrication and Construction .
        - Manufacture of powder.
        - Do. of other laboratory stores.
        - Foundry and Proof departments.
        - Carriage department.
      - Elementary Tactics
        - Repository course.
        - Field battery exercise.
        - Gun, mortar, howitzer, and rocket practice.
        - Infantry drill, and other exercises of arms.

These several branches are under the control of the Master-General and Board of Ordnance; more especially as regards the Finance and Matériel.—The Personnel is under the immediate orders of the Master-General.

SECTION II.

The administration of the Artillery (subject to the Master-General and Board of Ordnance) is distributed among the following departments; the head-quarters being at Woolwich.

1. The Personnel, under a Deputy-Adjutant-General.
2. The Equipment, under a Director-General of Artillery.
3. The Stores, before and after conversion, are under the control of a Principal Storekeeper.
4. The construction and fabrication of Stores for the Artillery are executed by the

   Laboratory Department.
   Carriage Department.
   Department of Inspector of Artillery.

5. The Theoretical branch for Cadets is under a Lieut.-Governor in charge of the Royal Military Academy.
6. And the Practical Course of Instruction is given under the direction of the above-named Departments, besides the most necessary practical duties taught in the Repository.

Referring to the preceding heads:

1. The Personnel of the Effective force forms one regiment of Royal Artillery divided into battalions and troops, according to the exigency of the Service: the minimum Peace Establishment (1852) being seven troops of Horse Artillery and twelve battalions of eight companies of Foot Artillery; and the maximum force, as a War Establishment, has been equal to fourteen troops of Horse Artillery, ten battalions of ten companies of Foot Artillery, thirteen troops of Artillery Drivers, and two foreign battalions.

The Non-Effective force, consisting of Invalids and Master-Gunners, is usually in charge of towers and batteries; the latter being Store Accountants, the situation affords a handsome retirement to the deserving non-commissioned officers of the Royal Artillery.

The *Distribution* of the Personnel into Horse Artillery, destined to move with Cavalry; Foot Artillery, attached to field batteries, generally acting with Infantry; and the Artillery for garrison and Colonial duties, is arbitrary; and the whole is still one regiment, the men and Officers being applicable, in the course of service, to all these duties at the pleasure of the Master-General, as circumstances may direct.

2. The Equipment of Artillery for the field, for coast defences, sieges, and the armament and defence of places, is a combination of the elements of men, matériel, and horses, necessary for those services; and is *organized* by the Department of the Director-General of Artillery. Under his control, batteries are equipped for the field, either for

   Horse Artillery.
   Rocket Artillery.
   Field Foot Artillery.
   Mountain Artillery.
   Artillery of Reserve or Position.

And the Equipments of Heavy Artillery are for

   Siege Artillery.
   Artillery for Coast Defences.
   Artillery for the Armament of Places.

3. Artillery Stores, and materials for conversion, are generally obtained by contract, and placed in charge of the Storekeeper-General's Department for distribution or conversion, as explained in the following paragraph, or in the Equipments named above.

4. The construction and fabrication of Artillery from the materials into the component parts of ammunition, ordnance, and carriages, are executed in the Royal Arsenal, Woolwich; and the proving of those articles, when furnished by private individuals or companies, forms an important branch of the Artillery Service.

5 and 6. The Elements of Instruction referred to in the preceding Synopsis are fully adequate, theoretically and practically, to render the men and Officers excellent Artillerists.

In concluding the description of the administration and organization of the Royal Artillery, it should be explained that this arm of Her Majesty's forces, after leaving the establishment at Woolwich, is under the command of the General Commander-in-Chief of Her Majesty's Land Forces, and obeys all Commanders of forts, districts, garrisons, and colonies, with all troops of Her Majesty's Army, subject to certain responsibilities of economy, detail and expenditure of money and stores, to the Master-General and Board of Ordnance.

SECTION III.

The application and proportion of Artillery to

Field and Positions . . .	See 'Composition of Batteries,' Table I.; and 'Equipment.'
Sieges	
Armament of Places, and	
Coast Defences	

As there is no regulated or fixed principle in the application of Artillery to the several services before mentioned, and as the question interests every branch of the British Army, the following data are given as the probable basis for the armament of batteries.

SECTION IV.

Artillery, applicable to the field, consists of

Horse Artillery Batteries.
Field Foot „ „
Mountain „ „
Rocket „ „
and Artillery of Reserve or Position.

1. The batteries of *Horse Artillery* are usually composed of 6-pounder brass guns and 12-pounder howitzers in batteries of six pieces, as best adapted to move with Cavalry. See Tables F. I.

2. The armament of the *Field Foot Artillery* attached to the Infantry Corps, when the roads are tolerably practicable, are now formed of 9-pounder brass guns and 24-pounder brass howitzers. (See Tables F. I.) But as the difficulties of moving artillery increase, so must the calibre of the ordnance be reduced. The field batteries in the early part of the Peninsular War consisted of 3 and 6-pounder brass guns, and of $5\frac{1}{2}''$ and $4\frac{2}{5}''$ howitzers: at the conclusion, 9-pounder guns were used.

3. The *Mountain Artillery* is usually limited to 3-pounder brass guns, and $4\frac{2}{5}''$ howitzers, conveyed on the backs of mules: the difficulty of transport renders it convenient to compose these batteries of three guns and one howitzer, as the ordnance

carriage and ammunition have to be fixed on pack-saddles. See Tables F. and I.; 'Carriage,' Pl. XXIX.; and 'Equipment.'

If the animals for the conveyance of Mountain Artillery are not well accustomed to carry weights on their backs, and used to mountain roads, the application of this branch of Field Artillery is very difficult.

Rocket Artillery for the Field seems more applicable to countries without roads than Mountain Artillery; and also where they are much intersected by rivers, and in marshy or boggy districts; as well as for Advance Guards. Hitherto, their practical effect has not been satisfactory. See Table J.

Artillery of Position or *Reserve* may be composed of 9 and 12-pounder brass guns, 24 and 32-pounder brass howitzers; or the 18-pounder iron gun, with an 8-inch iron howitzer: if of brass, the batteries consist of six pieces; if of iron, of four only. This description of heavy Field Artillery, in *offensive* operations, becomes 'Artillery of Reserve,' to be brought forward in critical periods of attack, or to insure success when the adverse forces begin to waver; and it is peculiarly adapted to the attack of posts and villages. In *defensive* operations it may be termed 'Artillery of Position,' for the occupation of the prominent features in the field of battle, and commanding ground, securing the position by its superior fire. See Tables E. F. I.

The proportion of Field Artillery to an army is generally regulated by the description of the country in which the army is to act, and the means of transport; but these should rather decide the *nature* of the ordnance to be employed than the *quantity*, considering the vast resources of Great Britain. With the Anglo-Portuguese army in the Peninsula, the proportion of Artillery was as one to every thousand; and with the army of occupation in France, it was as three to every thousand men. Napoleon preferred two to every thousand, with a large proportion of ammunition; and this rule seems to be admitted in modern armies.

But the proportion of two pieces of ordnance for every thousand Infantry may be found better suited to our Service, considering how much the perfection of the Infantry force diminishes the quantity of Artillery necessary for an army.

Therefore, taking an army destined for the field as 60,000—of which 50,000 is Infantry—7500 Cavalry, and about 2500 Artillery, the maximum number of pieces of artillery will be 100 in the proportion of

5 batteries of Horse Artillery, or 30 pieces for 5 brigades of Cavalry.
9 batteries of Field Artillery, or 54 pieces for 8 divisions of Infantry.
3 batteries of Reserve or Position, 16 pieces for the whole force.*

Whether four, six, or eight pieces shall be the strength of the batteries, is generally a Professional or Artillery question; but its consisting of six does not appear to be imperatively necessary.

It would seem desirable to establish as a principle, that the Field Foot Artillery attached to Infantry should not possess the mobility of Horse Artillery; and that the latter should not have the power of the former, by being armed with pieces of heavy calibre, as the efficiency of Horse Artillery depends upon the facility of moving and supporting Cavalry.

* If there is an excess in the proportion of Artillery to the rest of the army or corps, it should form part of the Reserve Artillery, so as not to impede the movement of the troops, and be available for the points most required.

SECTION V.

HEAVY ARTILLERY.

1. *Application of Artillery to Sieges.*—In the consideration of this subject also, the same two important points have to be decided—the nature of the ordnance to be employed, and the quantity. Adverting to the several sieges during the last wars, and the suggestions offered on the experience obtained from those events, the following inference is drawn as to the nature of Artillery necessary for a siege operation.

NATURE OF ORDNANCE.

That the 24-pounder iron 9 feet 6 inch gun should be generally, if not invariably, used for direct fire and breaching.

That the 8-inch iron howitzer, with the 24-pounder iron gun, is most suitable for enfilade fire, as well as for the demolition of parapets and exposed scarps when placed in the first parallel.

And that the 10-inch and 8-inch brass mortar be adopted for vertical fire, whether used for bombardment and the destruction of the magazines and platforms, or ultimately as pierriers, this latter piece not being known in our Service.

These, with a proportion of small mortars, will be found, as regards the nature of the Artillery necessary, more effectually to produce early and successful results. Although the 12 and 18-pounder iron guns are still among the enumerated descriptions of ordnance for the attack of places (see Table E.), experience does not justify their use, except in cases where none other can be obtained; and as Sir John Jones, in his 'Journals of Sieges,' observes, "It is neither vertical, ricochet, nor direct fire alone, but a judicious combination of the three which will prove irresistible;" and hence the

24-pounder gun for direct fire,
8-inch howitzer for ricochet, and
10-inch mortar for vertical,

are proposed for a battering train of heavy artillery to accomplish these objects.

QUANTITY OF ORDNANCE.

The quantity of ordnance necessary is equally important in the attack of places. There is a considerable difference in the authorities hitherto given of the number of pieces of artillery required, and the experience obtained in the reduction of fortresses rather shews that the quantity used was guided by expediency and the accidental resources of the moment.

The following proportion has been adopted (by a Committee of Artillery Officers in 1819, *see* 'Equipment,') as a siege equipment or battering train, and 100 pieces of heavy ordnance is given as the basis for all future siege operations.

Iron ..	24-pounder guns . . .	40 pieces.	100.
	12 " " . . .	20 "	
	Howitzers	15 "	
	Mortars	25 "	
Brass .	$5\frac{1}{2}$ mortars	20 "	40.
	$4\frac{2}{5}$ "	20 "	

But independent of the objection to the use of 12-pounder guns, which did not meet the sanction of the Duke of Wellington, proposed for enfilade fire, and the small number of howitzers, the quantity recommended does not seem a convenient number to divide for inferior attacks; and it is questionable if the number is adequate as a maximum proportion.

It is suggested therefore to establish a minimum quantity for the smallest siege operation.

Lieut.-General Sir J. Burgoyne, in the article 'Attack,' considers 25 pieces of heavy ordnance as the minimum battering train to belong to an army for the reduction of forts.

It is conceived that 30 pieces of heavy ordnance, with a proportion of brass mortars, as a small battering train for an Artillery siege equipment, should be considered as the minimum quantity, in the proportion of

Iron ..	24-pounder guns . . .	15, or $\frac{3}{6}$	30.
	8-in. howitzers	10, or $\frac{2}{6}$	
	10 mortars	5, or $\frac{1}{6}$	
	+		+
Brass .	8-in. mortar	5, or $\frac{1}{6}$	10.
	$5\frac{1}{2}$ "	5, or $\frac{1}{6}$	

See 'Construction' of Artillery, Sect. VI.

This minimum siege equipment it will be found more convenient to double, triple, or quadruple, than to divide the larger proportion of 100 pieces of heavy ordnance for the attack of fortresses of second and third, or fourth orders.

Sir J. Jones proposes, in his work on 'Sieges,'

Iron ..	24-pounders	40	106 pieces of heavy artillery.
	18-pounders or heavy howitzers	20	
	Mortars	46	

The 'Aide-Mémoire à l'usage des Officiers d'Artillerie,' (edition of 1844,) gives the following as a siege equipment:

Brass .	24-pounder guns	40	162 guns of heavy artillery.
	16 " "	40	
	8-in. howitzers (22cs.) . . .	40	
	10-in. mortars (27cs.) . . .	15	
	8-in. " (22cs.) . . .	15	
	Pierriers	12	

And in the same work the following examples are detailed of different siege equipments:

As proposed by	Pieces of Ordnance.	In the proportion of, per 100, Guns.	Howitzers.	Mortars.	Pierriers.
Vauban	160	70	—	15	15
Bousmard	168	50	18	22	10
Durtubie	207	62	12	18	8
Dupuget.	200	65	12	18	5
Gassendi	160	62	15	15	8
Austrian Equipment .	178	45	13	35	7
Prussian " .	142	60	15	20	5

It appears likewise in Jones's 'Sieges,' that the undermentioned pieces of artillery were in battery at the attacks of the following places by the British Army, upon

	Guns, Iron.		Howitz., Iron.		Carron.	Mortars, Iron.		Field Ordnance.
	24-prs.	18-prs.	$5\frac{1}{2}$-in.	8-in.	8-in.	10-in.	13-in.	Brass pieces.
Ciudad Rodrigo	23	4	—	—	—	—	—	2
Third siege of Badajos . .	16	20	16	—	—	—	—	4
St. Sebastian .	30	6	—	7	4	15	1	—

And in the 'Aide-Mémoire d'Artillerie,' the following were in battery in the French sieges in Spain:

		Number of Pieces of Ordnance.	In the proportion of, per 100, Guns.	Howitzers.	Mortars.	Pierriers.
Mequinenza .	in 1810	18	55	45		—
Ciudad Rodrigo	„ 1810	50	58	16	22	4
Almeida . .	„ 1810	67	62	18	13	7
Tortosa . . .	„ 1810	50	40	60	—	—
Lerida . . .	„ 1810	40	6	15	15	—
Tarragona . .	„ 1811	66	—	—	—	—
Badajos . . .	„ 1811	54	62	23	15	—

These examples are to be taken only as matters of fact, of what has been effected under the then existing circumstances and the resources of the French and British Armies, both distant from their several dépôts; but it is the discrepancy of the several propositions given in the authorities before quoted which suggests the proportion herein advocated, of having, as before stated,

24-pounder guns $\frac{3}{8}$ths.
8-inch howitzers $\frac{3}{8}$ths.
10-inch mortars $\frac{1}{8}$th.

And which, however, corresponds nearly with the latest siege equipages recommended by the French Officers in 1844, more particularly in the introduction of the large proportion of 8-inch howitzers; and Sir John Jones, in his 'Journals of Sieges,' Note 29, observes, "the recent improvements in the 8-inch and 10-inch howitzers will naturally, in future sieges, be made to supplant most of the guns hitherto used for enfilading." *

This arrangement combines the advantages of effect and simplicity, as likewise of economy, in the application of three descriptions only of heavy ordnance to the attack of places, and affords, by adopting a minimum quantity (30) for siege equipments, much convenience in transport, when embarked for any operations of an Army not specifically arranged beforehand, but presumed on the probable wants of a campaign.

The scheme of adopting small siege equipments instead of the maximum of the several propositions of

100 of the Committee of Royal Artillery,
100 of Sir John May, Royal Artillery,
106 of Sir John Jones, Royal Engineers,
162 of French Artillery Officers,
or 200 of several authors,

is left for consideration; but the disuse of 12 and 18-pounder guns is a simple question of calculation, the effects of these, as to time, being in the experiments at Metz, in 1834, in the inverse ratio of the weight of shot; and the effect calculated for the destruction of the parapets and traverses may be considered in the inverse ratio of the cubes of the diameter of the shot or shell of the

$$\left.\begin{array}{l}\text{8-inch howitzer}\\ \text{24-pounder gun}\\ \text{18}\quad\text{,,}\\ \text{and 12}\quad\text{,,}\end{array}\right\}\text{Iron.}$$

* See 'Siege Operations in India,' vol. iii.

And whether it is a question of time, effect, or economy of transport, this proposition for Artillery for sieges, consisting of

Maximum Equipment	120	60 — 24-pounder guns . .	or, 4 × 15	30	Minimum Equipment
		40 — 8-in. howitzers . .	„ 4 × 10		
		20 — 10-in. mortars . .	„ 4 × 5		
		120 and			
	+	40 — Small brass mortars .	„ 4 × 10	+ 10	
	= 160			= 40	

obviously embraces either part or the whole of these advantages.

It is assumed that a corresponding Engineer Equipment will accompany it, and not with the expectation of reducing a place with artillery alone.

In the 'Application of Artillery to the Field,' there is a proposition for reducing small posts by means of Artillery of Reserve; and this, with what other proportion of Field Artillery may be attached to the besieging army, will serve to arm the works constructed to protect the flanks of the parallels, and be useful against sorties.

2. *Coast Defences.*—The arrangement best suited for the armament of maritime places and batteries, for the protection of harbours, roadsteads, rivers, and coasts, is the combination of the 8-inch gun of 65 cwt., 56-pr., 32-pr. long iron gun, 13-inch iron mortar, and 68-pounder iron gun, for all positions; and none under these calibres should, it is conceived, be mounted in coast defences, to contend with the present armament of ships of war.

It appears that the relative importance of Artillery for Coast Defences in these suggestions is—

The 8-inch gun.
32-pounder gun.
13-inch mortar.
56-pounder gun.

The application is more fully explained in the article 'Defence of Coasts.'

3. *The Application of Artillery to the Defence of Places.*—There does not appear to be any rule in our Service for the armaments of forts and fortresses. In the French Service, by their latest regulations on this head, it is directed that the fortified places should consist of three classes, according to their relative importance; and the Artillery necessary is divided into two portions, the one being appropriated for the immediate security of the place, and the other that which is necessary to sustain a siege: the former is always mounted in battery, and the latter placed in store.

The quantity necessary for the immediate security of the place is calculated at 10 pieces per bastion, which provides for the armament of the salients and flank defences, as well as for the emplacement of the heavy mortars; but that requisite to sustain a siege must depend on the extent of the works generally, and is determined from the best and latest authorities: thus fortresses of the

				S =
First class,	consisting of 10 sides and upwards to the right line,		require	110 pieces.
Second class,	„	6 to 10 sides, of 180 toises front,	„	70 „
Third class,	„	4 to 5 sides, of 150 toises front,	„	30 „

in addition to the 10 per bastion.

The French authors adopt the following mode of expressing the total number (x) of Artillery necessary for a fortress, on having the number of bastions (m) and the value of S, as given above:

$\overline{m \times 10} + S = x$. S representing the quantity for the front of attack; thus, supposing the octagon the work to be armed, the quantity required will be $\overline{8 \times 10} + 70 = 150$ pieces.

The proportion of Artillery is usually $\frac{5}{10}$ of heavy guns,
$\frac{1}{10}$ „ howitzers,
$\frac{3}{10}$ „ mortars,
$\frac{1}{10}$ „ field pieces,

The nature and disposition of these being regulated by the previous arrangement explained, of first providing for the immediate security, and secondly, the Artillery necessary to sustain a siege.

For the first it is suggested that the armament might advantageously in our Service consist of

8-inch gun of 65 cwt., and 32-pounder guns for the salient angles of the bastion, mounted on traversing platforms.
24-pounder guns for the flank defences, on ground platforms.
10-inch howitzers in the salient angles of ravelins, en barbette.
13-inch mortars in the bastions, or curtains, for vertical fire.*

This Artillery for Immediate Defence will be used likewise during the early period of attack, the number necessary, as above stated, being ten pieces per bastion.

That necessary to sustain a siege, in addition to the above, should consist, it is conceived, principally of 18-pounder long iron guns, on travelling carriages,
$6\frac{1}{3}$ howitzers (Dundas) ditto,
8-inch mortars,

These being in store previous to the investment.

As an example to explain the quantity and nature of Artillery necessary for an octagon under both emergencies, in the proportion of $\frac{5}{10}$, $\frac{1}{10}$, $\frac{3}{10}$, and $\frac{1}{10}$, the following is given.

Nature of Work.	Guns.			Howitzers.		Mortars.			Field pieces.	Total.
Octagon.	*a.* pr. 32	*c.* pr. 24	*f.* pr. 18	*b.* in. 10	*g.* in. $6\frac{1}{3}$	*d.* in. 13	*h.* in. 8	*i.* in. $5\frac{1}{2}$	*e.* Brass.	
For Immediate Security	8	32	—	8	—	24	—	—	8	80
To sustain a Siege . .	—	8	27	—	7	—	11	10	7	70
	8	40	27	8	7	24	11	10	15	
	75			15		45			15	150

Application of the Artillery to the Defence.

a. To be mounted on salient angles of all bastions of enceinte; those of the fronts attacked being brought, after the first period, to the curtains of collateral fronts.
b. To be mounted in salients of ravelins; those of the fronts attacked being removed to angles of the shoulder of the collateral bastions.
c. For the flank defences; those of the fronts attacked being reinforced at the second period of defence.
d. To be divided off to the several bastions.
e. In the outworks and for sorties.
f. For the second period of defence, and armament of the faces of the fronts of attack.
g. Ditto.
h. For the outworks at the second period of defence.
i. For the covert-way at ditto.

* Probably the collateral bastions will be found most convenient for the heavy vertical fire.

In the event of the fortress having an interior elevated line of works, or cavaliers, commanding the surrounding country, the 68-pounder and 56-pounder guns are recommended, particularly for the early period of defence.

In maritime places, the artillery for the sea faces will be regulated by the rules providing for the armament of coast defences.

The selection of artillery for the defence of fortresses is not based upon the principle which guided that proposed for the attack; the latter having in consideration the difficulty of transport, which in the former is of minor importance. Hence the 13-inch mortars, 10-inch howitzers, and 32-pounder guns are proposed especially for the early period of defence; and the 24-pounder guns for the flank defence, as combining calibre with facility of working the pieces.

For the second period of defence, the 18-pounder guns and $6\frac{1}{2}$ howitzers are selected, their mobility being of some consequence at that period; and the shot or shell of those pieces being quite equal to penetrate the newly-formed parapets of the besiegers.

SECTION VI.

CONSTRUCTION OF ARTILLERY.

Some remarks are now offered with the preceding observations on Artillery, and with reference to the Tables and drawings explaining the dimensions, weights, and ranges of iron and brass ordnance for Land Service.

The Tables A. B. C. do not correspond precisely with what has been suggested as applicable in the preceding part of this article to the different services detailed for the field, for sieges, defences of coasts and harbours, and for the armament of places, as those propositions are founded upon the improvement of artillery, which implies the abandonment of a large proportion formerly in use.

For example. At an early period, the short and small calibre iron guns were introduced for the convenience of the Navy; such as the 6, 9, and 12-pounder guns of various weights. For the same purpose the carronades were brought into the Service, from the 12 to the 68-pounder; they were generally adopted for Land and Sea uses; and at the close of the war, a species of ordnance, combining the gun and carronade, was introduced by Sir William Congreve for the armament of ships. These varieties are nearly all set aside in the British Navy, and it is armed generally with one calibre*—the 32-pounder, of different lengths and weights, adapted to the size of the vessel; thereby insuring an effective gun, as well as establishing uniformity, and preventing confusion in serving the ammunition. The larger vessels, from the frigates upwards, have a proportion (about $\frac{1}{10}$th) of the 8-inch gun, for firing shells or hollow shot.

As one department (that of Artillery) supplies all the Ordnance, whether for the Land or the Sea Services, these changes throw a great quantity into store; and they are used as circumstances require.

Adverting to the construction of artillery and the above-mentioned variety, it would seem desirable to establish for the *Land Service* one construction peculiarly suited by its calibre,† so that the piece shall be most perfect of its kind, in respect to its range and weight; and the terms 'light,' 'medium,' and 'heavy' should be obsolete; this distinction being unknown to other Services, except those in which our system has been copied. In making a selection amongst pieces of different

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* See 'Equipment, Naval.'

† Colonel Dundas observes, it is a question whether, in respect to General Bloomfield's construction, any other form is better.

calibre, the decision will be much influenced by the weight of ammunition thereby entailed; but when the question lies amongst ordnance of the same calibre and of different weights, there can be no economy in, no plea for, dragging along a gun of imperfect and unsatisfactory character.

The following observations refer to construction; first, as regards the $6\frac{1}{5}$ howitzer, lately introduced by Colonel Dundas into the Service, of 10 calibres and 17 cwt. It would be desirable to have as a corresponding piece the $6\frac{1}{5}$ mortar of brass, and to consider the $4\frac{2}{5}$ mortar as too small and inefficient; the smallest in the French Artillery being 15 centimetres, or about 6 inches.

Secondly. Difficulties occur in siege batteries when the howitzer is used, in consequence of the muzzle not entering into the throat of the embrazure; the cheeks are then blown away, and the men exposed after a few rounds are fired. Two expedients might be adopted to remedy this inconvenience; either to provide for mounting the 8-inch howitzer on garrison carriages, or to lengthen the piece to eight calibres corresponding with the 68-pounder carronade; but this last plan would involve difficulties in building a travelling carriage of sufficient strength.

Thirdly. If the 10-inch mortar is considered sufficient for siege operations, and the maximum calibre for the mortar in the French Service is 27 centimetres (about 10·63 inches), the construction of a 13-inch Land Service mortar of range equal to that of the 56-pounder gun—3500 yards—may be worthy of consideration for coast defences, and the armament of places, as the question of transport is not of importance in such cases, or the use of the Sea Service mortar.

The following pieces of artillery may be considered as sufficient to meet all the wants of the Land Service, notwithstanding the numbers yet retained in the Service, as a matter probably of convenience and economy, as given in Tables A. B. C.

Guns	*a.*	68-pounder and 8-in. gun.	Iron.
	a. b.	56 " " "	
	a. b.	32 " " "	
	b. c.	24 " " "	
	b. c.	18 " " "	
	e.	12 " " "	Brass.
	d.	9 " " "	
	d.	6 " " "	
	f.	3 " " "	
Howitzers	*b.*	10 inch.	Iron.
	a. c.	8 "	
	b. c.	$6\frac{1}{5}$ "	Brass.
	d.	$5\frac{1}{2}$ " and 24-pounder.	
	d. f.	$4\frac{2}{5}$ " and 12 "	
Mortars	*a. b.*	13 "	Iron.
	b. c.	10 "	
	b.	8 "	
	b. c.	$6\frac{1}{5}$ "	Brass.
	c.	$5\frac{1}{2}$ "	
Application	*a.*	Sea defences.	
	b.	The armament of places.	
	c.	Sieges.	
	d.	Field Artillery.	
	e.	Ditto of reserve.	
	f.	Ditto for mountains.	

It will be perceived, that in the British Service all the light (or field) artillery is at present constructed of brass, and that all the heavy is of iron.

For the Theory of Construction, see 'Gunnery,' and some valuable observations in Jones's 'Sieges,' (Note 17, vol. i. second edition.) G. G. L.

ARTILLERY TABLES.

REMARKS AND NOTES.

TABLES A. B. C.—Very few systematic constructions of Ordnance being extant, and the varieties amongst those for guns of the same calibre being notorious, the plan of giving one General Table of Dimensions for all Ordnance now in the Service has been adopted, taking care, as much as possible, to represent like parts in all by the same letters.

For the execution of the very laborious task of filling in these Tables from actual admeasurement, we are indebted to the Inspector of Royal Artillery.

Note A, Table A. With reference to the forms of 'Bored-up' guns, which at present hold an intermediate place between the 'Ordinary' and 'Millar' constructions, the practice is variable, as the operation itself was experimental. Generally speaking, guns of 'ordinary' proportions were placed in the lathe, and modified somewhat to Millar's shapes, by the second reinforce being sloped to nearly a continuation of the chase, and by the moulding beads being turned off to flat fillets. In some instances, metal has been taken off inside and outside, whilst in others the bore only has been increased, and that even by two calibres.

Note B, Table B. In Carronades, the 'length of the bore' does not include the cup at the muzzle.

Note C, Table B. In mortars, the bore is divided into two parts—chase and chamber; the chase extends from the face of the piece to the seat of the bottom of the shell; the chamber comprises the remainder of the conic frustum occupied by the charge; but in the Tables, 'length of bore' is given as from the face of the mortar to the bottom of the chamber.

D.—This Table was specially applied for as an authority, in consequence of the variation of calibres of the same denomination; thus, there are no less than five different calibres for the 32-pounder, as now in the Service.—*Vide* Griffiths. Ed. 2, p. 61.

E.—This has been circulated as an order by the Master-General and Board. Two columns, for calibre, and point blank, have been added for this work.

F.—Compiled from the best authorities, as far as materials could be obtained.

J.—This gives all that is considered necessary for general purposes.

ARTILLERY TABLE A.

CONSTRUCTION OF

Service.	Construction.		Length.	Weight.	A.B.	A.C.	A.D.	A.E.	A.F.	F.G.	A.H.	A.I.	A.J.	A.K.	A.
			LENGTHS.												
			′ ″	cwt.	″	″	″	″	″	″	″	″	″	″	″
S.	M.	10-in. gun	9 4	86	22·4	44·8	56	99·5	112	109·33	16·02	5·52	67	109·5	27·15
S.	M.	68-pr. ,, ...	10 10	113	26	52	58·5	115·7	130	123·4	16·8	5·07	65	127·17	29·2
S.	M.	68 ,, ...	10 0	95	24	48	56·12	107·2	120	113·9	15·83	4·7	61·17	117·28	27·76
S.	M.	68 ,, ...	9 6	87	—	—	—	—	—	—	—	—	—	—	—
S.L.	M.	8-in. ,, ...	9 0	65	21·6	43·2	54	95·94	108	105·27	14·73	5·16	60·5	105·86	23·5
S.	M.	8 ,, ...	8 10	60	21·2	42·4	53	94·16	106	103·35	14·72	5·12	59	103·92	22·8
S.	M.	8 ,, ...	8 0	52	19·2	38·4	45·6	84·67	96	93·7	14·65	4·41	50·59	94·11	22·75
L.	M.	8 ,, ...	6 8½	50	22·5	34	40·25	68·5	80·5	80·5	15·5	5·46	44·35	77·98	22·8
L.S.	M′.	56-pr. ,, ...	11 0	98	26·4	49·5	59·4	117·48	132	124·86	15·1	4·91	63·21	129·1	28
L.	M′.	56 ,, ...	10 0	85	24	45·75	54	106·8	120	113·08	14·82	4·8	57·53	117·38	27·6
S.	M.	42 ,, ...	10 0	84	24	48	54	106·8	120	114	14·74	4·88	60	117·34	26·42
S.	M.	42 ,, ...	10 0	75	—	—	—	—	—	—	—	—	—	—	—
S.	O.	42 ,, ...	9 6	67	22·8	44·175	52·135	101·59	114	108·62	13·96	4·59	57·335	111·35	24·62
S.	M.	32 ,, ...	9 7	64	23·08	46·16	57·7	102·575	115·4	110·6	12·72	6·18	65·42	112·49	22·25
S.	O.	32 ,, ...	9 6	56	32·6	48·9	55·31	102·24	114	107·2	11·19	2·73	—	111·67	20·27
S.	O.	32 ,, (a bored-up 24)	9 0	46	—	—	—	—	—	—	—	—	—	—	—
S.	O.	32 ,, ...	8 0	48-50	27·42	41·13	47·54	86·31	96	89·22	11·25	2·28	—	93·89	20·9
S.	M′.	32 ,, (Monk's A.)	9 0	50	21·6	41·85	48·6	96·12	108	103·08	12·14	4·33	51·83	105·59	22·46
S.	M′.	32 ,, (Monk's B.)	8 6	45	20·4	39·53	45·9	90·78	102	97·23	11·95	4·12	48·98	99·82	21·97
S.	M′.	32 ,, (Monk's C.)	8 0	42	19·2	37·2	43·2	85·44	96	91·25	11·94	3·85	46·06	93·83	21·9
L.	I.	32 ,, (a bored-up 18)	8 0	41	—	—	—	—	—	—	—	—	—	—	—
L.	I.	32 ,, (a bored-up 24)	7 6	40	—	—	—	—	—	—	—	—	—	—	—
L.	I.	32 ,, (a bored-up 24)	7 6	39	—	—	—	—	—	—	—	—	—	—	—
L.	I.	32 ,, (a bored-up 24)	6 6	32	22·28	33·42	38·33	70·24	78	71·79	9·43	1·42	—	76·45	19·76
L.	I.	32 ,, (a bored-up 18)	6 0	25	18·82	30·02	34·45	61·72	71·15	66·58	9·06	2·07	36·03	69·69	18·1
L.	M.	32 ,, ...	5 4	25	12·82	25·64	32·05	56·088	64·1	64·1	15	4·6	38·73	62·59	17·68
L.	O.	24 ,, ...	9 6	50	32·6	48·9	54·723	102·16	114	107·41	10·47	2·72	—	111·6	19·25
L.	O.	24 ,, ...	9 0	48	30·85	45·85	52·2	97·2	108	101·3	10·33	2·7	—	106	19·1
L.	I.	24 ,, (a bored-up 18)	8 0	37	—	—	—	—	—	—	—	—	—	—	—
L.	M.	24 ,, ...	7 6	41	25·714	38·571	44·394	80·88	90	84·932	12·2	3·6	47·994	88·15	20·92
L.	M.	24 ,, ...	6 6	33	22·28	33·42	39·25	70·24	78	72·932	11·3	3·175	42·425	76·45	19·935
L.	O.	24 ,, (a bored-up 12)	6 0	20	20·59	30·85	35·47	64·7	72	66·37	8·21	2·15	—	70·52	16·95

ARTILLERY TABLE B.

CONSTRUCTION OF

Service.	Construction.		Length.	Weight.	A.B.	A.C.	A.D.	A.E.	A.F.	F.G.	A.H.	A.I.	A.J.	A.K.	A.
			LENGTHS.												
			′ ″	cwt.	″	″	″	″	″	″	″	″	″	″	″
L.	O.	18-pr. gun.	9 0	42	30·86	46·29	51·582	96·7	108	101·75	9·55	2·56	—	105·725	18·2
L.	O.	18 ,, ...	8 0	38	—	—	—	—	—	—	—	—	—	—	—
L.	I.	18 ,, (a bored-up 9)	7 0	22	22·9	35·94	39·15	75·15	83·87	79·3	7·75	2	40·9	82·41	15·46
L.	I.	18 ,, (a bored-up 12)	6 0	20	20·57	30·85	34·31	64·7	72	65·95	8·21	2·15	—	70·52	15·92
L.	I.	18 ,, (a bored-up 9)	5 6	15	16·56	27·12	30·25	58·11	64·8	61·84	8·08	2·02	31·63	63·4	14·62
L.	O.	12 ,, ...	9 0	34	30·86	46·29	50·91	96·58	108	102·23	8·5	1·93	—	105·54	16·32
L.	O.	12 ,, ...	8 0	33	—	—	—	—	—	—	—	—	—	—	—
L.	O.	12 ,, ...	7 6	29½	—	—	—	—	—	—	—	—	—	—	—
L.	O.	12 ,, ...	6 0	27	—	—	—	—	—	—	—	—	—	—	—
L.	O.	9 ,, ...	8 6	28½	—	—	—	—	—	—	—	—	—	—	—
L.	O.	9 ,, ...	7 6	26	—	—	—	—	—	—	—	—	—	—	—
L.	O.	9 ,, ...	7 0	25	—	—	—	—	—	—	—	—	—	—	—
L.	O.	9 ,, ...	5 6	17	—	—	—	—	—	—	—	—	—	—	—
L.	O.	6 ,, ...	8 6	23	—	—	—	—	—	—	—	—	—	—	—
L.	O.	6 ,, ...	8 0	22	—	—	—	—	—	—	—	—	—	—	—
L.	O.	6 ,, ...	7 6	21	—	—	—	—	—	—	—	—	—	—	—
L.	O.	6 ,, ...	7 0	20	—	—	—	—	—	—	—	—	—	—	—
L.	O.	6 ,, ...	6 6	18	—	—	—	—	—	—	—	—	—	—	—
L.	O.	6 ,, ...	6 0	17	20·57	30·8	34·7	64·25	72	66·97	6·75	1·42	—	70·6	15
L.	O.	6 ,, ...	5 11	11	—	—	—	—	—	—	—	—	—	—	—
S.	O.	32-pr. carronade . .	3 11¾	17	2·9	15·9	20·2	41·68	47·71	42·6	15·6	21·34	42·03	43·55	17·46
S.	O.	24 ,, . . .	3 7⅖	13	2·63	14·47	18·4	37·75	43·4	38·76	14·38	19·42	38·08	39·72	15·68
S.	O.	18 ,, . . .	3 9¼	10	2·4	13·05	16·58	34·09	39·25	36·34	13·05	17·5	34·62	35·62	14·33
S.	O.	12 ,, . . .	2 8⅓	6¾	2·24	11·44	14·62	27·68	32·36	28·71	11·19	15·49	27·98	29·34	12·6
L.	M.	10-in. howitzer . . .	5 0	43	17·68	25·455	30	51·1	60	57·21	12	3·04	36	58·21	23·24
L.	M.	8 ,, . . .	4 0	22	14·24	20·35	24	41	48	45·75	9·6	2·71	29	46·43	18·6
L.	O.	5½ ,, . . .	3 4¾	15	—	17·46	20·38	37·9	40·76	32·75	7·84	2·55	21·48	39·5	17·5
S.	O.	13-in. mortar . . .	4 4	100	11·37	11·5	23·62	26·01	48·73	3·28	39·01	—	—	—	—
L.	O.	13 ,, . . .	3 3½	36	9·75	7·9	14·95	16·9	37·6	2	—	—	—	—	—
S.	O.	10 ,, . . .	3 9	50	8·75	11·3	18·32	20	42·5	2·5	31·25	—	—	—	—
L.	O.	10 ,, . . .	2 7½	18	7·5	8·125	13·125	15	26·25	1·875	—	—	—	—	—
L.	O.	8 ,, . . .	2 1¼	9	6	6·5	10·5	12	21	1·5	—	—	—	—	—

Ordnance.—IRON.

See Artillery Plates I. III. IV.

DIAMETERS.								Trunnions.			Thickness of Metal.		Calibre.	Chamber.			Remarks.
B.	C.	D.	E.	F.	I.	J.	K.	Diam.	Length.	Span.	At Breech.	At Muzzle.		Length.	Diameters.		
″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	M. Millar. M'. Monk. O. Ordinary. I. Intermediate between M. and O.; being Bored-up guns. S. Sea Service. L. Land Service. S.L. Both.
25	—	22·25	16·44	15·072	25·86	20·05	19·96	7·25	6	36·5	8·05	2·56	10	11·83	10	7·47	
26·5	—	23·5	16·13	14·64	27·56	21·3	19·22	8·12	6·5	38	9·89	3·23	8·12	—	—	—	
25·34	—	22·28	15·54	14·28	26·2	20·12	18·65	8·12	6·5	36·68	9·18	3·08	8·12	—	—	—	
													8·12				
22·3	—	19·8	14·08	12·68	22·3	17·95	16	7·25	6	33·3	7·16	2·3	8·05	13·43	8·05	5·88	
21·76	—	19·16	13·78	12·58	21·76	17·4	15·9	7·25	6	33·3	6·9	2·25	8·05	13·43	8·05	5·86	
21·7	—	18·7	13·75	12·57	21·7	17·2	15·8	7·25	6	32·55	6·9	2·27	8·05	13·4	8·05	5·93	
21·5	—	20·25	14·75	12·82	21·5	18·32	18	6	6	33·7	6·84	2·34	8·05	10	8·05	5·86	
25·15	—	21·1	13·92	12·4	26·35	19·6	17·8	7·65	6·5	36·5	9·51	2·34	7·65	—	—	—	
24·82	—	20·8	13·82	12·25	25·92	19·5	17·25	7·65	6·5	36	9·25	2·32	7·65	—	—	—	
23·72	—	20·96	14·34	12·95	24·7	18·96	18·24	6·97	6	34·26	8·98	2·96	6·97	—	—	—	
													6·97				
22·16	—	19·16	13·03	11·62	23·06	17·59	16	6·94	6	32·65	8·15	2·34	6·935	—	—	—	
20·75	—	18·58	12·55	11·18	20·75	16·32	15·97	6·41	6	32·34	7·2	2·39	6·41	—	—	—	
19·06	—	17·26	13·2	12·43	22·24	—	16·45	6·41	6·61	30·96	6·97	3	6·41	—	—	—	
													6·41				
19·5	—	17·51	12·8	11·86	22·43	—	15·95	6·41	6·6	31·325	7·26	2·72	6·41	—	—	—	
19·92	—	16·82	11·26	10·04	20·86	15·72	14·14	6·35	5·75	29·87	7·35	1·85	6·375	—	—	—	
19·52	—	16·48	11·1	9·92	20·4	15·41	14·12	6·35	5·75	29·87	7·16	1·78	6·35	—	—	—	
19·47	—	16·45	11·1	9·9	20·35	15·3	13·72	6·35	5·75	29·42	7·08	1·77	6·35	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	6·35	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	6·35	—	—	—	
													6·35				
17·75	—	15·98	12·04	10·22	19·93	—	13·99	5·82	5·9	26·28	5·65	2·5	6·3	—	—	—	
16·5	—	14·97	11·27	10·6	17·32	14	13·31	5·23	5	25·44	5·54	2·15	6·3	—	—	—	
17	—	15·48	11·54	10·6	17	13·66	13·8	5·292	4·25	24·92	5·36	2·14	6·3	—	—	—	
18·02	—	16·4	12·36	11·1	20·93	—	15·17	5·823	6	28·8	6·75	2·63	5·823	—	—	—	
18	—	15·8	12·3	11	20·9	—	15·16	5·823	6	28·75	6·44	2·59	5·823	—	—	—	
													5·823				
18·32	—	16·45	12	11·58	19·2	15·17	14·7	5·792	5·5	28·78	6·76	2·875	5·792	—	—	—	
17·505	—	15·88	12·04	11·25	18·41	14·72	13·99	5·792	5·5	28·12	6·35	2·71	5·792	—	—	—	
14·95	—	13·3	10·4	10·1	17·6	—	13·27	4·62	4·62	23·4	5·28	2·75	5·75	—	—	—	

Ordnance.—IRON.

See Artillery Plates I. II.

DIAMETERS.								Trunnions.			Thickness of Metal.		Calibre.	Chamber.			Remarks.
B.	C.	D.	E.	F.	I.	J.	K.	Diam.	Length.	Span.	At Breech.	At Muzzle.		Length.	Diameters.		
″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	M. Millar. M'. Monk. O. Ordinary. I. Intermediate between M. and O.; being Bored-up guns. S. Sea Service. L. Land Service. S.L. Both.
17	—	15·4	11·565	10·8	19·68	—	14·25	5·292	5·42	26·69	6·37	2·75	5·292	—	—	—	
													5·292				
14·54	—	13·22	9·15	8·62	16·44	12·46	11·4	4·21	4·21	21·92	5·13	1·79	5·174	—	—	—	
14·9	—	13·3	9·31	8·3	16·2	—	13·23	4·62	4·62	23·5	5·2	1·86	5·174	—	—	—	
13·65	—	12·46	8·93	8·26	13·93	11·66	10·98	4·15	—	—	4·4	1·52	5·174	—	—	—	
15·2	—	13·94	10·39	9·65	17·73	—	12·26	4·62	4·72	23·75	5·82	2·52	4·62	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	4·62	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	4·62	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	4·62	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	4·2	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	4·2	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	4·2	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	4·2	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	3·66	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	3·66	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	3·66	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	3·66	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	3·66	—	—	—	
13	—	11·85	8·7	8·8	15·06	—	11·45	3·7	3·85	19·8	5·08	2·54	3·66	—	—	—	
													3·66				
16·6	—	—	12·59	8·92	14·4	11·86	10·78	2·72	—	8	5·23	2·78	6·25	5·08	5·63	5·63	
15	—	—	11·5	8·11	13	10·78	10·21	2·46	—	7·25	4·85	2·6	5·58	4·58	5·04	5·04	
13·63	—	—	10·5	7·3	12·07	9·74	9·22	2·24	—	6·62	4·27	2·35	5·16	4·2	4·47	4·47	
11·98	—	—	9·27	6·45	10·43	8·6	7·86	2	—	5·78	3·78	2·05	4·52	3·65	4·06	4·06	
22·4	—	21·5	17·52	16·25	22·5	19·68	20·06	7·81	6	34·74	6·26	3·12	10	11·25	10	7·47	
17·94	—	17·25	14·06	13·08	18	15·76	16·4	6·25	5	28·6	4·97	2·52	8	9·5	8	6·14	
—	14·9	14·74	11·9	12·07	16·2	14	13·16	5·1	5·1	25·75	5·4	2·95	5·68	5·1	3·64	3·64	
—	—	34·95	35·75 {	34·52 34·92	(G.) 34·52	(H.) 35·75	—	11·37	8·53	52·81	—	10·76	13	15·1	9·7	7·31	
—	—	25·35	—	—	—	—	—	9·75	7·32	39·75	—	5·83	13	11·6	12·5	6·5	
—	—	26·92	27·5 {	26·5 26·97	(G.) 26·78	(H.) 27·5	—	8·75	6·56	40·62	—	8·08	10	11·7	7·5	5·6	
—	—	20·56	20	20	—	—	—	7·5	5	30·56	—	5·01	10	9·58	9·76	5·8	
—	—	16·5	16	16	—	—	—	4	6	24·5	—	4	8	7·5	7·76	4·55	

ARTILLERY TABLE C. CONSTRUCTION OF

Service.	Construction.		Length.	Weight.	LENGTHS. A.B.	A.C.	A.D.	A.E.	A.F.	F.G.	A.H.	A.I.	A.J.	A.K.	A.
			′ ″	cwt.	″	″	″	″	″	″	″	″	″	″	″
L.	O.	12-pr. gun (medium)	6 6	$17\frac{3}{4}$	21·83	34·93	39·553	70·82	78·6	74·55	6·73	1·2	——	77	13·82
L.	O.	9 ,, ...	5 11	$13\frac{1}{2}$	19·85	31·76	35·96	64·31	71·4	67·74	5·78	1·09	——	70·26	12·6
S.L.	O.	6 ,, . . (long)	7 0	12	27·1	37·33	40·47	75·43	84	80·35	5·84	1·2	——	82·74	11·55
L.	O.	6 ,, . . (light)	5 0	6	16·66	26·66	30·33	54·07	60	57·47	5·03	1	——	59·11	9·62
L.	O.	3 ,, . . (long)	6 $0\frac{4}{5}$	6	9·8	32·1	35	65·2	72·8	69·2	4·7	1·1	——	71·6	8·7
L.	O.	3 ,, . . (light)	4 0	3	13·33	21·32	24·32	43·14	48	46	4·1	1·1	——	47·24	7·64
L.	O.	3 ,, . (colonial)	4 0	3	13·3	21·6	24·2	43	48	45·5	3·8	1·5	——	47·2	7·6
L.	O.	3 ,, . (mountain)	3 0	$2\frac{1}{4}$	10	16	18·91	32·57	36	34	3·9	·64	——	35·25	7·65
L.	O.	1 ,, . (mountain)	5 0	$2\frac{1}{2}$	16·67	26·7	28·72	53·73	60	57·98	3·56	1	——	59·25	6·27
L.	M.	32-pr. howitzer (Dundas)	5 3	$17\frac{1}{2}$	17·85	27·3	31·5	57·56	63	61·16	7·26	——	34·78	61·67	14·25
S.L.	M.	24 ,, ...	4 $8\frac{1}{2}$	12	15·2	24·5	28·3	50·1	56·6	55·15	6·48	3·04	31·28	55·44	12·8
L.	M.	12 ,, ...	3 9	$6\frac{1}{2}$	12·2	19·82	22·7	40·2	45·2	45·11	5·25	2·13	25·2	44·29	10·2
L.	O.	$4\frac{2}{5}$,, . . (light)	1 $10\frac{3}{5}$	$2\frac{1}{2}$	6·49	11·28	14·08	20·9	22·6	16·1	3·67	1·69	——	21·9	8·47
L.	O.	$4\frac{2}{5}$,, . (Coehorn)	1 $10\frac{3}{5}$	$2\frac{3}{8}$	6·3	11·27	14·15	20·85	22·6	16·1	3·52	1·68	——	21·85	8·47
L.	O.	$5\frac{1}{2}$-in. mortar (Royal)	1 $2\frac{3}{5}$	$1\frac{3}{4}$	2·57	4·55	5·2	10·1	10·8	11·92	13·7	13·8	14·35	——	(G.) 7·37
L.	O.	$4\frac{2}{5}$,, . (Coehorn)	1 $0\frac{3}{5}$	1	2·1	3·95	4·48	8·4	9	10·13	11·8	11·9	12·43	——	(G.) 6·43

ARTILLER

Return shewing the Calibre of British Ordnance, and the Maximum and Minimum Diamete

		Nature of Ordnance.	ft.	in.	Calibre.	Diam. of gauges. Maxim.	Minim.	Mean diam. of shot.
			ft.	in.	inches.	inches.	inches.	inches.
1	IRON.	68-pr. gun } 8-inch guns.	9	0	8·05	7·95	7·9	7·925
2		68 do.	6	$8\frac{1}{2}$				
3		56 do.	11	0	7·65	7·51	7·45	7·48
4		32 do.	9	6	6·41	6·207	6·147	6·177
5		Do. do.	6	6	6·3			
6		24 do.	9	6	5·823	5·639	5·584	5·6115
7		Do. do.	9	0	do.	do.	do.	do.
8		Do. do.	6	0	5·75	do.	do.	do.
9		18 do.	9	0	5·292	5·124	5·074	5·099
10		Do. do.	6	0	5·17	do.	do.	do.
11		12 do.	9	0	4·623	4·476	4·432	4·454
12		6 do.	6	0	3·668	3·568	3·532	3·55
13		10-inch howitzer			10·0	9·88	9·8	9·84
14		8 do. do.			8·0	7·9	7·82	7·86
15		24-pr. do.			5·68	5·62	5·57	5·595
16		13-inch mortar			13·0	12·88	12·8	12·84
17		10 do. do.			10·0	9·88	9·8	9·84
18		8 do. do.			8·0	7·9	7·82	7·86
19		32-pr. carronade			6·25	6·207	6·147	6·177
20		24 do. do.			5·68	5·639	5·584	5·6115
21		12 do. do.			4·52	4·476	4·432	4·454
22	BRASS.	32-pr. howitzer			6·3	6·207	6·147	6·177
23		24 do. do. (Millar)			5·72	5·62	5·57	5·595
24		$5\frac{1}{2}$-inch do.			5·62	do.	do.	do.
25		12-pr. do. (Millar)			4·58	4·476	4·432	4·454
26		$4\frac{2}{5}$-inch do.			4·52	do.	do.	do.
27		12-pr. medium gun . .			4·623	4·54	4·505	4·523
28		9 do. do . .			4·2	4·117	4·082	4·1
29		6 do. heavy gun . . .			3·668	3·585	3·55	3·568
30		Do. light do. . . .			do.	do.	do.	do.
31		3 do. heavy and light do.			2·913	2·838	2·808	2·823
32		$5\frac{1}{2}$-inch mortar (Royal)			5·62	5·62	5·57	5·595
33		$4\frac{2}{5}$ do. do. (Coehorn)			4·52	4·476	4·432	4·454

ORDNANCE.—BRASS. See Artillery Plates I. II.

DIAMETERS.								Trunnions.			Thickness of Metal.		Calibre.	Chamber.			Remarks.
B.	C.	D.	E.	F.	I.	J.	K.	Diam.	Length.	Span.	At Breech.	At Muzzle.		Length.	Diameters.		
"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	
12·04	—	10·93	8·53	8·05	13·82	—	10·5	4·25	4·25	20	4·07	1·71	4·623	—	—	—	M. Millar. M', Monk, O. Ordinary.
11	—	9·96	7·8	7·36	12·6	—	9·6	3·87	3·87	18·21	3·67	1·57	4·2	—	—	—	
9·75	—	9	6·35	6·75	11·55	—	8·83	3·66	3·66	16·58	3·05	1·55	3·66	—	—	—	
8·29	—	7·53	5·84	5·51	9·62	—	7·57	2·94	3·5	14·8	2·53	·95	3·66	—	—	—	
7·5	—	6·8	5·1	5	8·7	—	6·9	2·7	3·2	11·3	1·92	·97	2·91	—	—	—	
6·5	—	5·6	4·64	4·35	7·64	—	6·01	2·36	2·55	11·3	1·98	·74	2·91	—	—	—	
6·5	—	5·9	4·6	4·2	7·6	—	6	2·2	2·6	11·5	2·32	·62	2·95	—	—	—	
6·55	—	5·87	4·62	4·38	7·65	—	5·8	2·32	2·36	10·95	2·35	·73	2·91	—	—	—	
5·1	—	4·65	3·74	3·53	6·27	—	4·81	2·21	2·5	10·1	1·85	·75	2·01	—	—	—	
13·58	—	12·95	10·2	9·6	—	12·06	12·1	4·62	4·5	22·8	4·3	1·63	6·3	10·26	6·3	5	S. Sea Service. L. Land Service. S.L. Both.
12·2	—	11·55	9·16	8·19	12·21	10·74	10·93	4·2	4·25	19·89	3·27	1·21	5·72	7·86	5·66	4·2	
9·65	—	9·44	7·5	7·72	9·66	8·75	9·45	3·6	3·6	17·05	2·57	1·59	4·52	6·8	4·49	3·4	
7·34	—	7·73	6·99	8·17	7·34	—	8·47	2·89	3·1	14·67	2·53	1·13	4·52	5·1	2·26	2·26	
7·34	—	7·73	6·99	8·17	7·34	—	8·47	2·89	3·1	14·67	2·53	1·13	4·52	4·8	2·26	2·26	
6·8	7·8	8·15	8·43	7·82	8·43	8·25	(H.) 8·28	2·8	3·3	15	—	·7	5·62	5·2	5·45	3·1	
5·87	6·85	7·1	7·34	6·85	7·34	7·2	(H.) 7·1	2·26	2·5	13·35	—	·68	4·52	3·9	4·25	2·5	

TABLE D.

of Shot and Shell; the Minimum exhibiting the greatest Windage possible to insure accurate practice.

Remarks and Observations.

} Shells and hollow shot.

1. The Maximum Gauge is a metal cylinder of three diameters in length, through which the shot and shell must pass; the Minimum, a ring through which they must not pass: the difference between the two being a necessary allowance made to the contractors for error in casting; the Minimum Gauge also determining when the degradation of the shot or shell shall have proceeded to such a length as to render them unserviceable.

Bored-up gun.

2. The proportion of windage for the older construction of ordnance, viz. Nos. 4, 6, 7, 9, and 11, which is somewhat less than 1-27th part of the diameter of the bore, having been, in consequence of the great improvement in the manufacture of shot and shells, considered no longer necessary, it has been reduced in all new constructions, and varies from 1-32nd to 1-45th part of the diameter of the bore; in no case exceeding ·2 inch, even for the largest guns. The windage for a given nature of ordnance, however, differs with the length of the piece, in order that a greater correctness and precision in practice may be obtained; and in the 32-pounders there are consequently the following varieties: viz. ·233 old construction, ·2; ·175, ·125, and with the carronade, ·073 of an inch.

In the shorter pieces, howitzers and mortars, the windage is, for the same reason, brought to the very lowest practicable limit.

Weights, Dimensions, &c. of Common Shells.

For Field Service, Mast.-General & Board's order. 27th March, 1843.

	13-inch.	10-inch.	8-inch.	5½-inch.	4⅖-inch.
Weight	1 cwt. 3 qrs.	3 qrs. 10 lbs.	1 qr. 12 lbs.	14 lbs. 0 oz.	7 lbs. 0 oz.
Exterior diameter	12·88 in.	9·88 in.	7·88 in.	5·57 in.	4·43 in.
Thickness . . .	2·05 ,,	1·57 ,,	1·2 ,,	..	..
Actual content of Powder . . }	11¼ lbs.	4½ lbs.	3 lbs.	..	..
Bursting charge .	6¾ ,,	2⅝ ,,	1⅞ ,,	0 lbs. 10 oz.	0 lbs. 5 oz.

ARTILLERY TABLE E.

Table of Pieces of Iron Ordnance which are to be used in the Armament, generally, of Works, Forts, Towers, and Sea Batteries.

	Nature of Ordnance.	Length.	Calibre.	Weight.	Charge.	Ranges. P. B.	Ranges. 2°	Ranges. 5°	Ranges. 8°	Ranges. 12°	Recoil.	How mounted.	Remarks.
		ft. in.	in.	cwts.	lbs.	yards.	yards.	yards.	yards.	yards.	feet.		
1	8-inch shell gun	9 0	8·05	65	10	300	1130	1920	2400	3010	6½	Upon traversing or ground platform as required.	This gun to be used with hollow shot, shells, and spherical case, also common case. Useful against shipping, to command roadsteads and approaches, and it may be considered as equal in power to the heavy 32-pounder.
2	8 do.	6 8½	8·05	50	8	210	1050	1800	2250	2870	8½	Ditto	Proposed as a substitute for the 68-pounder carronade for flanks and interior defences; also for commanding landing places. Ammunition as in former case.
3	32-pounder gun	9 6	6·41	56	10	400	1130	1964	2335	3030	7	Ditto	The power and range of this piece of ordnance points it out as one of the best guns for distant ranges against shipping, &c. Hot shot, in addition to the usual ammunition.
4	32 do.	6 6	6·3	33	5	360	1050	1740	2200	2800	11½	Upon bracket carriage and ground platform.	This gun is for flanks and all purposes of a shorter range. Ammunition as above, to be associated with No. 3.
5	24 do.	9 6 or 9 0	5·82	50 or 48	8	400	1100	1850	2240	2960	6½	Upon bracket carriage and traversing or ground platform.	The range somewhat less than from a 32-pounder; but it is a useful gun, and for general purposes hardly inferior to it.
6	24 do.	6 0	5·75	20	2½	—	750	1280	1750	2200	9½	Ground platform.	For flanks and short ranges: good gun for common and spherical case. To be associated with No. 5. Substitute for 24-pounder carronades in casemates, &c.
7	18 do.	9 0	5·29	42	6	400	1050	1770	2230	2820	6	As Nos. 1, 3, and 5	The range of this gun is considerable, and it may be useful against the approaches of boats, &c. It is fitted for the land fronts of works which may be exposed to desultory attack, and where rapid firing may be necessary.
8	18 do.	6 0	5·17	20½	3	—	765	1300	1780	2250	9	Ground platform.	For flanks and short ranges.—To be associated with No. 7.
9	12 do.	9 6	4·62	34	4	400	1000	1520	1940	2700	5	Ground platform.	This gun to be used as No. 7. Under many circumstances it will be useful.
10	6 do.	6 0	3·66	17	2	360	940	1470	1880	2400	4½	Ground platform.	Principally intended to be mounted on saluting batteries.
11	10-inch howitzer	—	10·0	41	7	—	650	1100	1770	2410	8½	Ground platform.	These powerful pieces may be used for faces, flanks, interior defences, and against enemy's cruizers; their weight is such as to allow of their being moved from place to place as may be required.
12	8 do.	—	8·0	21	4	—	600	1000	1650	2000	7½	Ground platform.	
13	5½ do.	—	5·68	15	2	—	730	1200	1700	2175	10	Either on ground platform or dwarf traversing.	A convenient piece on works to move about as necessary, and for towers of weak construction.
14	13-inch mortar	—	13·0	36	9	—	Extreme range			2900	—	———	No remarks here necessary.
15	10 do.	—	10·0	18	4	—	Extreme range			2400	—	———	
16	8 do.	—	8·0	9	2	—	Extreme range			2000	—	———	
17	56-pounder gun	11 0	7·65	97	16	—	1390	2260	2760	3560	6½	Sliding carriage recoiling on dead blocks and traversing platform.	For positions requiring very distant ranges.

NOTE.—*Iron Carriages and Iron Traversing Platforms.*—The question of the suitability and efficiency of iron garrison carriages and iron traversing platforms for works of defence, not liable to enfilade or direct heavy fire, having been repeatedly entered into, and the trials to which they have been subjected at different times and places having given satisfactory results, it has been considered expedient to maintain the use of such carriages and platforms in the Service, and the Master-General and Board concurring in the opinion expressed in a Report of a Select Committee of Artillery Officers, dated 31st May, 1833, that iron carriages are "considered efficient for the armament of the Coast, and of Fortresses in time of peace, with due precaution that in every strong place there is a sufficient number of wooden gun carriages in store to be employed on the weaker front, or fronts, in the event of a regular attack;"—they direct that the proportions of iron carriages and iron traversing platforms, as compared with those of wood, be regulated accordingly in the Armament of Forts and other defensive works.

OFFICE OF ORDNANCE, *22nd January*, 1844.

The columns 'Calibre' and 'P. B.' have been added to the official document by the Committee; the additional matter from good authority, although the ranges are higher than have been usually given of late years.

ARTILLERY TABLE F.

Table of Brass Ordnance.—Ranges and Application.

	Nature of Ordnance.		Length.		Calibre.	Weight.	Full Charge.	Ranges.							Remarks.
								P. B.	1°	2°	3°	4°	5°	6°	
			ft.	in.	in.	cwt.	lbs.	yards.	yards.	yards.	yards.	yards.	yards.	yards.	
1	12-pr. gun	medium	6	$6\frac{1}{2}$	4·62	18	4								Batteries of reserve and position.
2	9 do.		5	$11\frac{1}{2}$	4·2	$13\frac{1}{2}$	3	300	700	1000	1200	1400			Foot batteries.
3	6 do.	long, or Desaguliers'	7	0	3·66	12	2								
4	6 do.	light	5	0	3·66	6	$1\frac{1}{2}$	200	600	800	1000	1200			Horse artillery; Foot batteries. One supplied to men-of-war of all classes from 120-26 guns inclusive; also to the larger steamers.
5	3 do.	long	6	$0\frac{4}{5}$	2·91	6	1								
6	3 do.	light	4	0	2·91	3	$\frac{3}{4}$								
7	3 do.	colonial	4	0	2·95	3	$\frac{3}{4}$								
8	3 do.	mountain	2	$7\frac{4}{5}$	2·91	$2\frac{1}{4}$	$\frac{5}{8}$								
9	1 do.	do.	5	0	2·01	$2\frac{1}{2}$	$\frac{3}{8}$								
10	32-pr. howitzer	Dundas	5	3	6·3	$17\frac{1}{2}$	3	370		735		1110		1430*	Attached to 12-pr. batteries of reserve and position; good gun for spherical case.
11	24 do.	Millar	4	$8\frac{1}{2}$	5·72	12	$2\frac{1}{2}$	200	450	650	850	1025			Attached to 9-pr. batteries, and to those of reserve and position. One supplied to men-of-war of all classes from 120-70 guns inclusive.
12	12 do.	Millar	3	$9\frac{1}{10}$	4·58	$6\frac{1}{2}$	$1\frac{1}{4}$		400	600	800	1000	1110†		Attached to 6-pr. foot batteries, and horse artillery.
13	$4\frac{2}{5}$ do.	Coehorn	1	$10\frac{3}{5}$	4·52	$2\frac{3}{8}$	$\frac{1}{2}$								
14	$4\frac{2}{5}$ do.	mountain	1	$10\frac{3}{5}$	4·52	$2\frac{1}{2}$	$\frac{1}{2}$								
15	$5\frac{1}{2}$-inch mortar	Royal	1	$2\frac{1}{3}$	5·62	$1\frac{3}{4}$									
16	$4\frac{2}{5}$ do.	Coehorn	1	$0\frac{2}{5}$	4·52	1									

* 8° .. 1770 yards.
10° .. 1980 „
12° .. 2280 „
14° .. 2580 „

† $5\frac{1}{2}$° .. 1150 yards.

ARTILLERY TABLE G.

Depression of Guns mounted upon Garrison Carriages.

					Degrees.	With elevating screw alone. Degrees.
Carriages, Garrison.	Gun, upon wood coin.	Wood carriage.	8-in.	65 cwt.	$3\frac{1}{4}$	
			32-pr.	56 „	5	
			24	50 „	3	
			18	42 „	$3\frac{1}{4}$	
			12	34 „	2	
		Iron carriage.	32-pr.	56 cwt.	4	
			24	50 „	4	
			18	42 „	4	
			12	34 „	$3\frac{1}{4}$	
	Carronade, block trail.	Wood carriage, upon wood coin.	68-pr.	. . .	9	$4\frac{1}{2}$
			42	. . .	$7\frac{1}{2}$	2
			32	. . .	7	2
			24	. . .	$6\frac{1}{2}$	2
			18	. . .	6	
			12	. . .	5	
		Iron, upon depression block and elevating screw.	24-pr.	. . .	14	$3\frac{1}{2}$
			18	. . .	15	$0\frac{3}{4}$
			12	. . .	16	2
	Howitzer, wood, upon the head of elevating screw and iron swing bed.		10-inch iron	.	1 *	
			8 „	.	$7\frac{1}{2}$ *	

N.B.—Several of the gun and carronade carriages at Gibraltar and St. Helena are mounted in a peculiar way, to give about 25 degrees depression.

The preceding, Table G, gives the depressions with the present construction; the following, Table H, shows what may be given, assuming the height of the genouillère at 2 ft. 3 in. or 2 ft. 4 in., so that all garrison guns may fire conveniently over it; and corresponding changes are contemplated in the construction of garrison carriages, so as to bring all guns to an uniform maximum Elevation of 10°, and a Depression of 2°;—this last as supposed to be sufficient for ordinary purposes, and all to be obtainable from the common coin. But when, as in case of towers, flanks of bastions, &c., &c., depressions to $6\frac{1}{2}$° or 7° are often necessary, so as to be able to take up ground beyond the effective range of musketry, the additional coin must be used. The carriage would possibly admit of more than the above, but the experiment would be hazardous without cap-squares.

The greatest depression that can be allowed with safety to 18, 24, 32-pr. garrison carriages, (which are all without cap-squares,) wood or iron, is 7° on traversing platforms, and $6\frac{1}{2}$° on ground platforms.

All elevations and depressions in Tables G and H refer to the horizon, and not to the platform.

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* Cap-squares are provided to effect this. In the Plate of the carriage for this piece it is given as with iron trunnion boxes, since superseded by cap-squares. See 'Carriage,' Pl. IV.

ARTILLERY TABLE II.

A Table shewing the Height, Elevation, and Depression of the following Ordnance, mounted upon Common Garrison Carriages.

Carriages.	Ordnance	Elevation upon: Stool bed laid on axle-tree.	Elevation upon: Stool bed.	Elevation upon: Block of carriage.	Depression: With elevating screw and depressing block.	Depression: With elevating screw.	Depression: With common coin.	Height: From platform to axis of gun. ft.	in.	Height: Under swell of muzzle at greatest depression. ft.	in.	Height: Under swell of muzzle at 5 degrees depression. ft.	in.
		°	°	°	°	°	°	ft.	in.	ft.	in.	ft.	in.
Guns. Wood.	8-in. of 65 cwt. and 9 ft.	16	10	,,	,,	,,	2	3	5½	,,		2	7¼
	32-pr. 56 ,, 9½ ,,	16	10	,,	,,	,,	2	3	6	,,		2	7¼
	24 50 ,, 9½ ,,	16¾	10	,,	,,	,,	2	3	5⅝	,,		2	7¼
	18 42 ,, 9 ,,	18	10	,,	,,	,,	2	3	4⅞	,,		2	7¼
	12 34 ,, 9 ,,	18¼	10	,,	,,	,,	2	3	4	,,		2	7¼
Guns. Iron.	32-pr. of 56 cwt. and 9½ ft.	,,	9½	,,	,,	,,	2½	3	6	,,		2	7¼
	24 50 ,, 9½ ,,	,,	10	,,	,,	,,	2	3	5¾	,,		2	7⅜
	18 42 ,, 9 ,,	,,	10	,,	,,	,,	2	3	2	,,		2	4⅜
	12 34 ,, 9 ,,	,,	10	,,	,,	,,	2	3	1½	,,		2	4¾
Howit., wood.	10-in. iron	,,	15	,,	,,	1	,,	3	5	,,		2	5½
	8 ,, ...	,,	16	,,	,,	7½	,,	3	3½	,,		2	6
Carronade Wood.	68-pr.	,,	,,	14	,,	5½	,,	3	7¼	2	8⅞	2	9½
	42	,,	,,	14½	13¼	3½	,,	3	3¼	2	3⅛	2	7
	32	,,	,,	17	14	3½	,,	3	1¾	2	2⅜	2	6⅜
	24	,,	,,	18	13	2	,,	3	0½	2	2¾	2	5⅞
	18	,,	,,	19	13	P.B.	,,	2	10½	2	1⅝	2	4⅜
	12	,,	,,	19	12	P.B.	,,	2	8¾	2	1⅜	2	3⅜
Carronade Iron.	24-pr.	,,	,,	12½	14	2½	,,	2	11¼	2	0¾	2	4⅝
	18	,,	,,	12¾	15	2½	,,	2	10	2	0¼	2	3⅞
	12	,,	,,	15½	16	2	,,	2	9½	2	0⅝	2	4⅛

ARTILLERY TABLE I.—Composition of Field Batteries.

Number and Species of Carriages, of which Horse Artillery, or Field, Batteries of each nature are composed.

	Field batteries.				Colonial batteries.				
							Mountain.		
Nature of batteries	pr. 18	pr. 12	pr. 9	Lt. pr. 6	pr. 3	pr. 3	pr. 3	pr. 3	pr. 1
Nature of howitzers	in. 8	pr. 32	24	12	$4\frac{2}{5}$		$4\frac{2}{5}$	$4\frac{2}{5}$	
No. of guns	3	5	5	5	3	4	3	3	4
Howitzers	1	1	1	1	1		1	1	
Ammunition Waggons — Guns	9	10	7	6	6 carts	4 carts	*	*	*
Ammunition Waggons — Howitzers	4	2	2	2	2 carts				
Spare carriage	1	1	1	1					
Waggon — Forge	1	1	1	1	†	‡	‡	‡	‡
Waggon — Store	2	2	1	1					
Waggon — Platform	1								
Store carts	1	1	1	1	§	‖	§	§	§
Total carriages	23	23	19	18	12	8	4	4	4
No. of rounds per gun	180	148	166	223	154	165	165	108	232
,, per howitzer	112	114	144	236	80		96	72	

The composition of the howitzer batteries seems not to have been yet decided on.

Composition of Batteries. 1st. The batteries were composed of five guns and one howitzer,¶ with the exception of 18-pounder batteries, which are to consist of three guns and one 8-inch howitzer.

2nd. In case of reserve batteries formed of howitzers only, to consist of six pieces and their appropriate carriages.

Rounds per piece. 3rd. The number of rounds per piece required to sustain an action of some duration has been assumed as a criterion to regulate the ammunition waggon to accompany a battery of each nature, independent of reserves.

Distribution of Ammunition. 4th. Adhering to the uniformity of packing, and the power of substituting one limber or waggon for another, the old proportion of case shot was considered too great; **Common Case.** a diminution of it has taken place, and that which is to be retained is to be of one sort, viz. 41 balls in tins for guns, which has permitted an increase in the number of rounds. The case shot for howitzers to be not less than 4-oz. balls.

Spherical Case. 5th. The spherical case is less efficient in the lower natures than the higher, and is altogether useless in the 3-pounder; the average proportion of it to the total number of rounds per piece is nearly as follows:

---

* Ammunition carried on mules' backs.

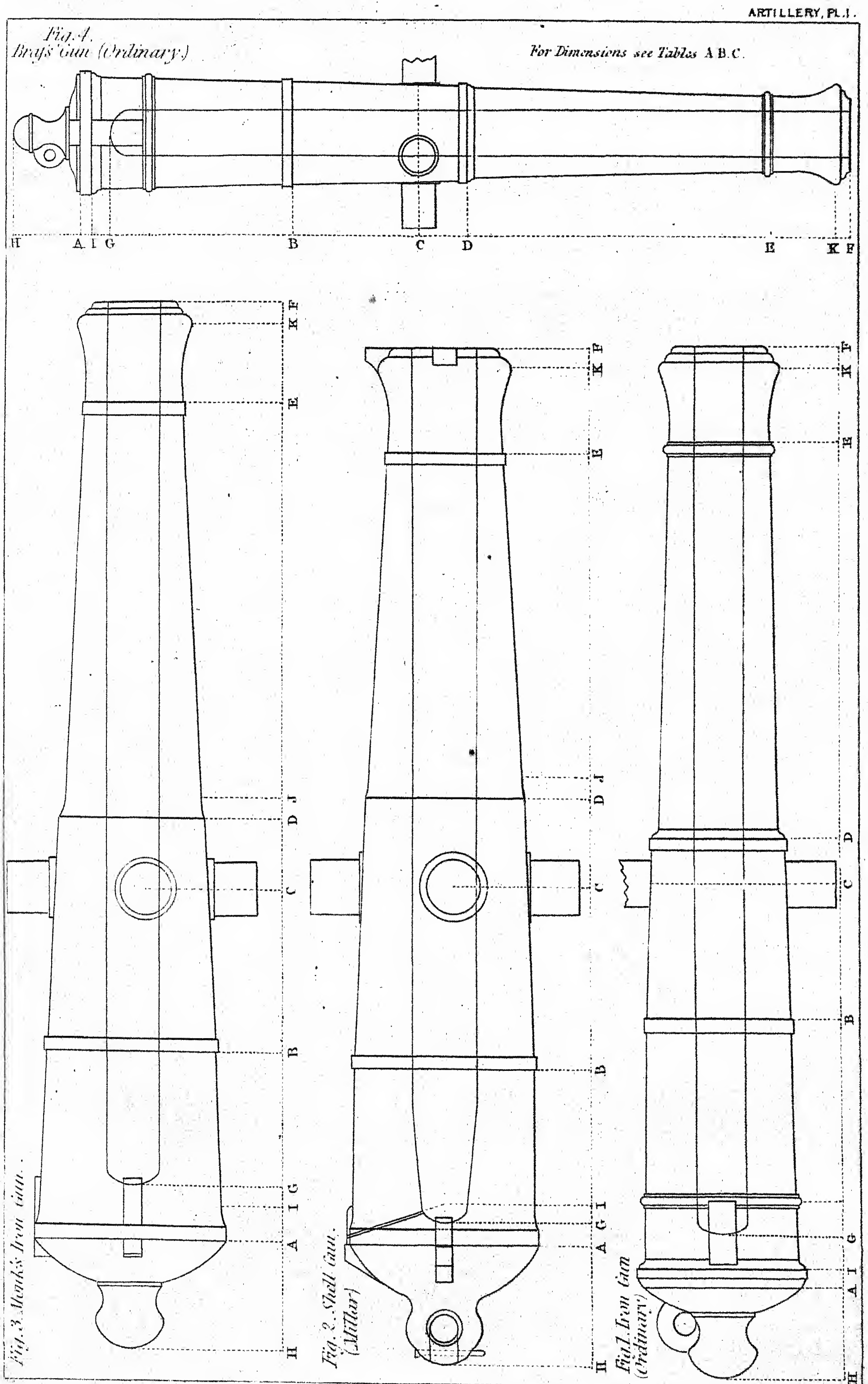
† There ought to be a small forge for this battery, carried on two mules.

‡ A forge on back of two mules.

§ There ought to be a small cart drawn by two mules, for a spare wheel, mules' shoes, stores, and tent, &c.

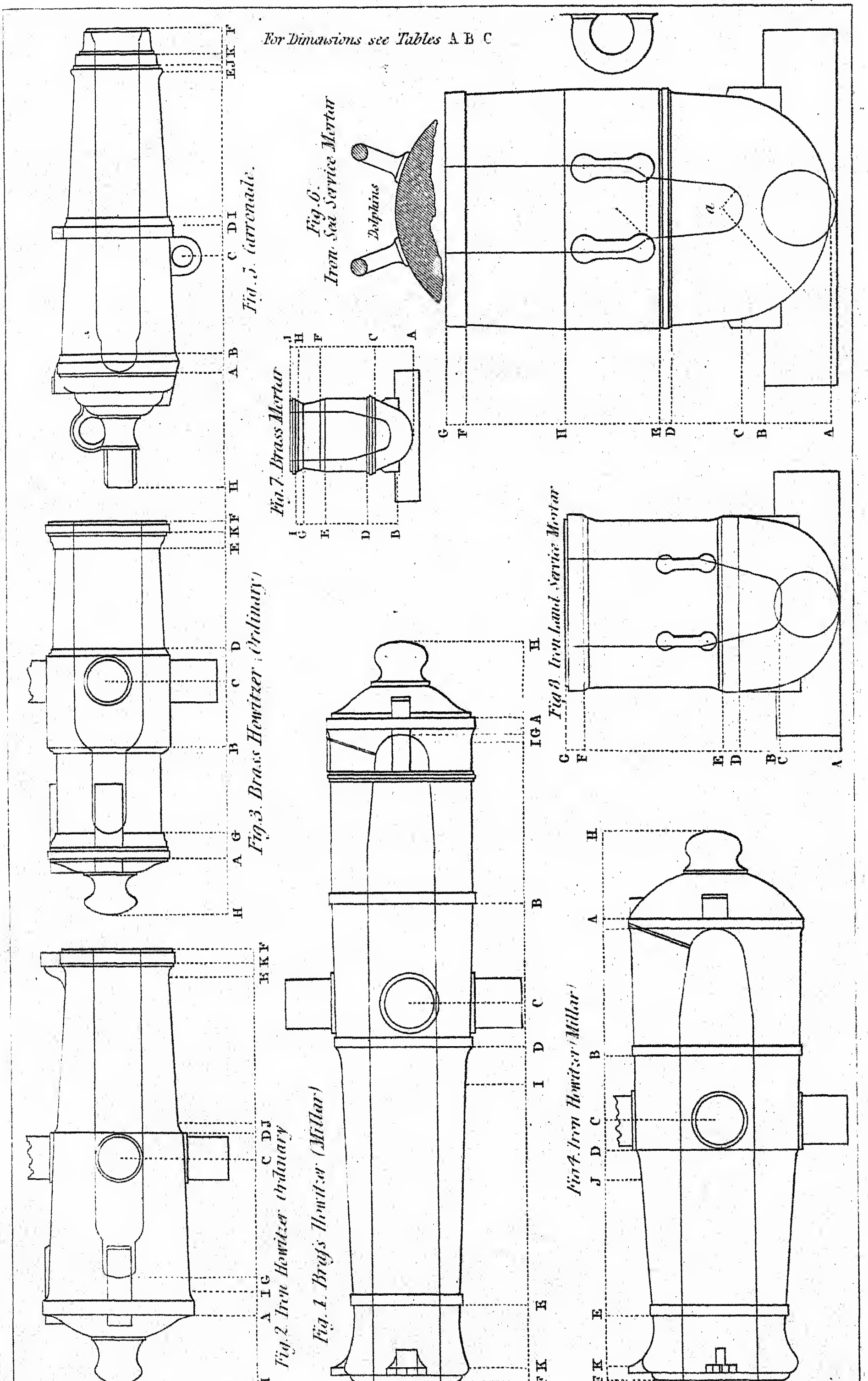
‖ Two mules, for mules' shoes, stores, and tent.

¶ Now (1852) of four guns and two howitzers.



J. W. Lowry fc.

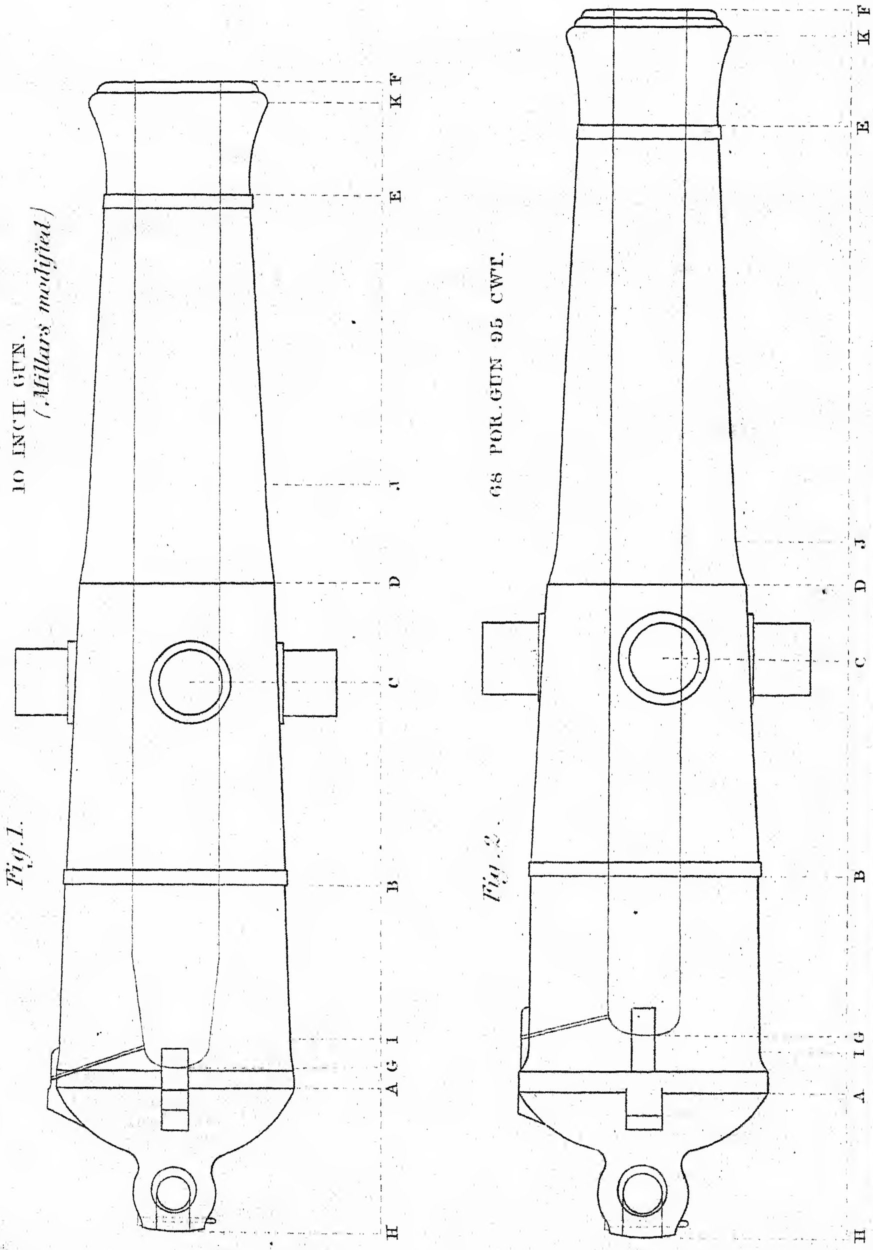
J. Weale 59 High Holborn 1844.



J.W. Lowry fc.

John Weale, 59, High Holborn 1844.

For dimensions see Table A.



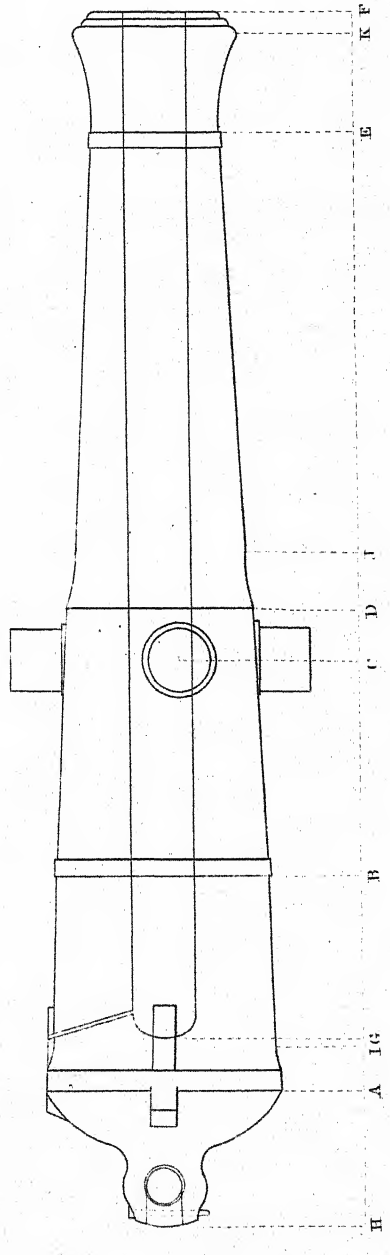
G. Shepherd Serj.t R.l Art.y

J.W. Lowry fc.

John Weale, 59, High Holborn, 1852.

For dimensions see Table A.

42 POR. GUN. 84 CWT.



G. Shepherd Serjt. Rl. Artʸ.

J. W. Lowry fc.

John Weale 59 High Holborn 1852.

8-inch, 32-pounder, 24 ,, 12 ,,	howitzer	$\frac{1}{2}$
18-pounder gun		$\frac{1}{4}$
12 ,,		$\frac{1}{3}$
9 ,,		$\frac{1}{4}$
6-pounder, light		$\frac{1}{8}$

Spherical, Spare Ammunition. 6th. The proportion of ammunition embarked for three months' consumption to be at least four times the quantity immediately accompanying each battery.

Colonial Service. 7th. A scale of equipments is added for smaller ordnance for local circumstances, such as light 3-pounder 4-feet, and Coehorn or $4\frac{2}{5}$-howitzers on carriages of single draft, and carts for ammunition, and also for the 1-pounder ammuzette. These pieces are particularly adapted to the West Indies and other Colonial Services, where the limited movements they have to make must be regulated by the draft of mules or by the assistance of men.

8th. Scales have been formed for Mountain Service according to the two modes in most frequent use of the 3-pounder and Coehorn and $4\frac{2}{5}$-howitzer of that construction, viz. the one by pack-carriage altogether, and the other by draft, a shaft carried by a mule attached to the trail of the gun carriage.

Shaft to Trail. 9th. The latter mode (the shaft to trail) is infinitely to be preferred, as being easier for the mule, more readily brought in and out of action, as conveying more ammunition with the same power, and as being able to move on almost any road over which the former is capable of being transported.

10th. That of pack-carriage is quite ineligible, and ought only to be resorted to when there is no other resource. The gun weighs 252 ℔s., and the howitzer 280 ℔s. This dead weight is concentrated on the top of the mule's back, and if by a false step or motion of the animal the weight inclines over the one side, the pack-saddle turns round and comes under the mule's belly; the piece cannot be put on the saddle without the greatest exertion of the men, and even then it requires that the animal should stand perfectly motionless.

See 'Equipment,'—'Artillery,'—'Mountain,' and 'Carriage.'

ARTILLERY TABLE J.—Rockets.

General Memoranda on the Elevations, Ranges, and Lengths of Fuze at which the Shell may be expected to burst in the new-pattern Rocket, in which the hollow head serves either as Shot or Shell.

	24-pounder.		12-pounder.		6-pounder.		3-pounder.	
Lengths of Composition.	Elev.	Range yds.	Elev.	Range yds.	Elev.	Range yds.	Elev.	Range yds.
If the whole length of the fuze be left in the shell . . .	47°	3300	40°	3000	37°	2300	25°	1800
If the whole of the fuze composition is bored out, and the rocket composition left entire	27	2000	20	1500	15	1100	12	850
If the rocket composition be bored into within one inch* of the top of the cone	17	700	10	420	10	420	8	420

* In the 24-pounder $1\frac{1}{2}$ inch.

ATTACK.*—By Lieut.-Gen. Sir J. F. Burgoyne, G.C.B., R.E.

ATTACK OF FORTRESSES.

NUMBER OF TROOPS FOR A SIEGE.

The attempt to lay down a scale for the number of troops required for a Siege, in proportion to the size of the place or strength of its garrison, must be delusive. In one case double the number of the garrison may be sufficient, while in another six times its force may be inadequate.

The calculation will depend upon many contingencies; among the principal are,

1. Whether the besieging army will have any exterior force to guard against.
2. Whether the inhabitants of the adjoining districts are friendly or hostile; and if the latter, the extent of their energy, or power of annoyance.
3. Whether the garrison would be favourably circumstanced for making sorties, or the reverse.
4. The extent of labour and duties which would be required of the besieged, in proportion to the strength of the garrison.
5. The quantity of work and duties that would be required of the besieging force.
6. Facility or otherwise for procuring timber, brushwood, means of transport, and other accessories, in the neighbourhood.
7. Abundance or deficiency of Artillery and Ammunition, as well of Engineers' or Sappers' tools and stores, will influence in a great degree the number of troops of the Line necessary.
8. Consideration of the means of the besieged in the same particulars.

The Commanding Engineer, if well informed on the nature and circumstances of the place, as it is to be presumed he would be, would form his project of attack in detail, and calculate from the above and other considerations the force necessary for the operations.

Every species of service and duty must be brought into account, but the principal ingredient will be the number of men that must be daily actually *in* the trenches, employed in the *guard* of the works or working parties, as well for Artillery as for Engineers, giving them the proper number of reliefs.

If the Besieging Army was equal only to eight times the average number required constantly in the trenches, the service would be very hard; it would be equivalent to an assumption of each man having eight hours' working party duty, or twenty-four hours' guard actually in the trenches every fourth day; † but in fact, from the number of men who never do that duty, such as cavalry, bands, orderlies, servants, men in charge of horses and sick, &c., the duty would be found to come at least once in three days, or probably nearer to every other day, upon the remainder, which would be far too severe.

The distance which many of the troops will have to march from their encampment to the trenches must also be considered.

The camp and fatigue duties, foraging, and procuring and preparing materials for the siege, would afford heavy work for the proportion not in the trenches.

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* This article chiefly comprehends general principles: the details will be found under such heads as 'Battery,'—'Sap,'—'Mining,' &c.

† This calculation is on the assumption of half the number being on guard, and half working party: as these proportions are altered, so will be the calculation; and also, if the working parties are relieved every twelve hours instead of eight.

The Cavalry do no duty in the trenches, but will be proportioned to the service required for orderlies, escorts, maintaining communications, also for despatches, and pickets to oppose any sorties that may be expected to extend to any distance from the fortress. They are also employed in collecting materials for the siege, particularly any that are small in bulk, and can only be obtained at a distance, such as brushwood of best quality, and in particular that fit for gads or bindings for the fascines.

The Artillerymen must be proportioned to the force of the batteries, and should be in sufficient numbers to take upon themselves all that service that requires peculiar instruction and exercise, without occasion for other assistance from the Line than is wanted as ordinary manual labour, of which at times they will require a considerable amount.

OFFICERS OF ENGINEERS.

The smallest siege of a fort will require nine; that is, three brigades of two each and three Staff.

If the operation be somewhat larger, and to last ten or twelve days, there should be twenty Officers.

A regular hexagon attacked on the principle of Vauban would need forty Officers.

Sappers and Miners cannot be in too great numbers: if perfectly efficient and well trained, each Sapper in a siege will be worth three men of the Line up to a certain considerable number. They should, if possible, do every species of trench-work, excepting what is of the most ordinary character; and by the facility and regularity with which they would perform it, a great deal of time would be saved, fewer men be required in the trenches, and much fewer casualties occur.

Each brigade of Officers should have the assistance of six men, to lay out the works and keep the working parties to a correct performance of their task.

Each head of a Sap, allowing for regular reliefs, will require twenty-four.

For revetting batteries, six men per gun.

Of the parties making fascines and gabions, one-fourth should be Sappers, particularly at first.

The following may partly be made up of artificers from the Line.

For preparing and afterwards laying platforms, four carpenters each.

For each gallery of a mine, requiring support by frame-work, four carpenters.

These two last suppose the plank and wood to be ready prepared, at least in the rough.

For cutting out sleepers and planks in the woods, two pair of sawyers, per pit, should produce one platform from each pit in two summer days, including cutting down and trimming the trees, &c.

For a moderate siege of a fortnight or three weeks, where twenty Officers of Engineers and twenty-five pieces of artillery are employed, the number of Sappers should not be less than 400.

A front of fortification attacked, according to Vauban, would require at least double that number, besides Miners in addition, where necessary.

Where they are not in sufficient numbers, a selection of artificers from the Line are attached to the corps for the siege, and receive such hasty instruction as can be given to them; but they are far inferior to Sappers.

As we know from experience that the Sappers can become as well disciplined and good soldiers as any other troops, they would act as perfectly efficient battalions, during periods of movements of the army in which their peculiar services as Sappers would not be required; while for attack or defence of posts, throwing up intrenchments, passage of rivers, forming or destroying bridges, &c., &c., their services would be invaluable.

There is a greater reason for a large proportion of Sappers, as, in an ordinary campaign, the nature of their duties will probably lead to greater losses than are commonly sustained by soldiers of the Line.

Although men from the Line instructed for the occasion will be but a very imperfect substitute for regular Sappers who have a thorough knowledge of their business, they would be extremely useful to assist them in the artificers' works, and for performing various operations that require a greater degree of knowledge and intelligence than can be expected from the soldiers who may be found promiscuously in the working parties.

From 200 to 600 (according to the class of siege) of such men, selected, paid and encouraged, and attached for the siege to the Engineer Department, would expedite the operations, lead to a reduction in the numbers required for the ordinary working parties in a far greater proportion than their own force, and enable the works to be more perfect.

STORES.

The Artillery and Stores for a siege-train in general might, perhaps, be conveniently arranged in *proportions*, commencing with a small one for attacks of forts or small posts.

The details for the Artillery Service are for the consideration of that particular branch; but 25 or 30 pieces of heavy ordnance, including about 13 mortars and howitzers, with about 1000 rounds of ammunition per gun, and 500 per mortar and howitzer, might be considered as one proportion, adapted to very small sieges; to be multiplied according to the probable exigencies of the anticipated campaign.—See 'Artillery,' Section v.

The following may be esteemed a reasonable proportion of the principal Engineers' stores for the smallest siege.*

List of Engineers' Stores forming one proportion for a small Siege.—Some of the weights are estimated only.

Actual weight by experiment. cwt.	lbs.		Estimated weight. cwt.	lbs.
		2000 Pickaxes ($\frac{1}{10}$ pole or Miners' picks) . .	182	0
		1800 Shovels	93	0
		200 Spades	10	0
13	0	200 Felling-axes.		
3	80	50 Broad axes.		
40	0	2200 Spare helves for different tools.		
7	56	300 Bill-hooks.		
0	56	5 Pit saws.		
1	0	10 Cross-cut saws.		
1	10	60 Hand saws.		
1	8	30 Adzes		
		30 Augers		
		30 Two-feet Rules		
		30 Planes	8	0
		3000 Spike nails		
		2 Boxes of nails of sorts		
7	71	30 Crow-bars.		
5	39	30 Sledge hammers or pin mauls.		
		30 Gabion knives.		
		60 Topping-axes.		

* See 'Equipment,'—'Siege,'—'Engineer.'

Actual weight by experiment. cwt.	lbs.		Estimated weight. cwt.	lbs.
		10 Sap forks	9	0
		90 Earth rammers		
		2 Chests of Carpenters' small tools . . .	4	0
		* 2 Do. of Masons' and Miners' do. do. . .		
		Miners' large tools for 3 Brigades . . .	3	0
		Masons' do. do. for 6 Brigades . . .	6	0
254	0	20,000 Bushel sand-bags.		
7	0	60 Fascine chokers.		
		25 Gun platforms, 18 ft. × 12	650	0
		5 Mortar do. 8 × 8	42	56
		1 Forge cart, with Smiths' tools	80	0
		Coals and steel for repairing tools . . .	12	0
		2 Hand-screw jacks		
		2 Large double-blocks and tackles	7	0
		2 Coils of 3-inch rope		
		2 Ditto 1½ ditto		
		150 Platform screws, with nuts	3	0
		2 Steelyards, complete		
		10,000 yards of Hambro' line, for tracing works .		
		10,000 yards of broad white tape, for night do. .		
		100 yards of saucisson or powder hose, made up	6	0
		100 yards of canvas for do. or other purposes		
		Files, Setters, Dogs, Boxes, Chalk lines,		
		Grease, &c., for saws of all sorts . . .		
		30 Masons' Levels		
		40 Plumb-bobs, with lines		
		30 Dark lanthorns		
		300 lbs. of Candles for do. and Miners . . .	18	0
		20 Grind-stones		
		20 Rub or Whet-stones		
		Twine, coarse, Packing-needles, &c. . .		
36	0	21 Marquees.		
		21 Bell tents.		
		Plans, Papers, Books, Instruments, &c. .	6	0
		180 Joints of scaling ladders, 10 feet long each	100	0
		4 Large tarpaulins	4	0

When the stores are to be conveyed by water, whether by sea, or river, or canal, and the means of transport are consequently plentiful, the stores may be greatly increased, and the service much expedited thereby. Platforms, timbers, and even fascines and gabions, can in such case, perhaps, be prepared previously, and at a distance, and conveyed to the siege.

Under any circumstances, a large proportion of every description of the small stores should be included, because they are easily carried, and may add much to the facility of the operations.†

* Chests of tools are no longer supplied: assortments are demanded as required.—*Editors.*

† The preceding list makes no allowance for casualties: there must be ample provision for such stores as bill-hooks, shovels, sand-bags, &c., &c., which are always liable to be purloined;—and every practicable arrangement should be adopted to prevent such losses.

All these estimates of men and means are given as the minimum of what are considered most appropriate and desirable, without being at the same time extravagant. Where exigencies of the Service require operations to be performed by small means, which is too often the case, of course the attempt must be submitted to, and the best made of those that may be available up to a certain point, when it may be the duty of the Commanding Engineer to declare them to be insufficient to afford any reasonable prospect of success.

INVESTMENT, ENCAMPMENTS, AND LINES OF CIRCUM- AND COUNTER-VALLATION, &C., UP TO THE OPENING OF THE TRENCHES.

The Investment is usually effected as much by surprise as possible, in order to shut the place up in as unprovided a state as may be.

It need not be complete (in occupying the entire circumference round the place), but it should be efficient; that is, the garrison should be shut up from receiving any succour, either in men or means, that can be of important service to it, or from a power of acting upon the flanks of the approaches.

At the siege of Badajos, in 1811, the right bank of the river was left open to the garrison for a few days, which was of no consequence as regarded any succour to be obtained from thence; but it gave a power which was taken advantage of, to run out guns day by day, which at a long range enfiladed the trenches.

The Encampments will very seldom be in the formal precise order found in the old books of Attack and Defence, of a circle round the place just out of gun-shot; but in the different positions which the country shall present as most favourable for the convenience of the troops and the service that each part may be called on to fulfil. An important point, likely to be forced, either from within or without, will naturally be taken up in the manner that shall present the strongest features for defeating such attempts.

In occasional situations, it may be desirable to draw the encampment somewhat close to the place: favourable undulations of ground may enable this to be done with security and to great advantage. In others, the troops may be at a greater distance, in positions favourable for other objects.

The same reasoning applies to Lines of Circum- and Counter-vallation, the effect of which would generally rather be obtained by adapting the position of the troops and defences to the features of the country under the ordinary principles of military positions and intrenchments, than to a regular circular line round the place, the applicability of which under the present mode of warfare can scarcely be conceived.*

Other considerations having been provided for as above, it will be desirable to bring the encampments of the several parts of the besieging force as conveniently near for reaching the trenches as possible; and as large a body of troops as can be allotted to one part should be encamped on the side to be attacked, in order to give peculiar security to the parks of artillery and several dépôts, and also to be more at hand for the duties of the siege.

The principal Engineers' Dépôt should be out of easy range from the garrison, and not only out of sight of it, but the access to it for stores and materials from different directions should be, as much as possible, unseen.

The parks of artillery must be peculiarly secured from risk of exposure to the fire from the garrison.

The fatigue of marching between the remote parts of the encampments and the trenches is so great an addition to the duties of the siege, that it will be an im-

* See 'Blockade.'

portant study, and worthy of some labour, to render the communications between them, in addition to being good and complete in bridges, &c., &c., *as short* as possible, consistently with security.

At the blockade of Malta, in 1800, advantage was taken of the ordinary loose stone-wall fences of the country; and by connecting and raising those that were convenient and parallel to the works, by closing gaps, and opening cross-walls, to effect a communication all round the fortress, in many parts not more than 200 or 300 yards from the place; and though only a screen, still being hidden from view, it was perfectly secure, and of great service. It was more costly and inconvenient to the garrison to destroy this screen than to the blockading force to maintain it.

In Fortresses besieged, a screen of mere canvas across narrow openings that were exposed to musketry has frequently enabled the communication to be maintained free and secure.

Hollow roads, covered ground, buildings, walls and hedges, &c., might, under many circumstances, be connected artificially into communications covered from view, that would be of great service in this way.

From the period of the first investment to the opening of the trenches, every necessary reconnoissance of the place is made by close investigation of the Officers of Engineers, who are to be protected while executing this service by covering parties of the troops.

The Plan of Attack being definitively arranged, the situations of the additional troops that may be brought to the immediate neighbourhood of the attack, as well as of the several dépôts, should be defined, and as many points fixed and marked for the approaches and works of the siege in detail as possible,—always under the greatest precautions against the garrison obtaining a knowledge of the proposed operations.

From the first period of the investment also, parties should be sent out to collect platform timbers, fascines, gabions, &c., &c., which should be brought in so far as can insure subsequently the least possible extra carriage to the final dépôts in rear of the attacks.

This will probably require the continued service of all the means of transport that brought up the stores in the first instance; and as the horses or cattle so employed must be subsisted in the district itself, in addition to Cavalry, Artillery, &c., it will tend, among others, to shew how many more difficulties are opposed to carrying on a siege in winter, than merely the effect of climate on men and animals.

OBJECT AND PRINCIPLES OF ATTACKS.

To ascertain what works will be necessary for any siege, it may be well to revert to first principles.

The object to be attained in the Attack of a Fortress is to make a breach or passage in its walls, capable of allowing it to be stormed with superior forces.

If the place has only a single line round it, and that exposed to view to the foot, or very near it, a single battery, established at from 200* to 400 yards distance, may be sufficient to effect the breach, and the troops can then storm the place at once.

Unless there should be natural cover up to the site of the battery, a covered approach must be made to it for the troops, and the guns taken by the most convenient roads or directions, independent of the approaches, during the night.†

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* Practicable breaches may be made from greater distances, by increasing the power of Artillery, and by an extension of time.

† It happens occasionally that daylight comes on while this is in operation, in which case any gun that may necessarily be left in an exposed situation is covered from view, as well as may be, by branches of trees, &c., &c., till the next night, and thus sometimes escapes observation.

In proportion to the fire of artillery that the garrison can bring to bear upon the single battery will be the difficulty of effecting the breach; or the breach may have a flanking fire to bear upon it (and a very small flank will have a powerful effect on the assailants): in either event these means of resistance, if too powerful, must be previously silenced or greatly reduced, which must be effected by other batteries, and probably by some works carried nearer.

When the garrison is in sufficient number, and has facilities for making sorties, the batteries must have covered communications to connect them, and cover for troops to support them; and in proportion to the force and facilities possessed by the garrison must these precautions be increased.

If the wall of the fortress be not exposed to fire from a distance, the breaching battery must be established nearer; and when it has a revetted counterscarp, the approaches must be carried close to it, to enable a clear passage to be formed to the breach.

Certain outworks under different circumstances will demand similar works of Attack; and during the whole proceeding there must be covered approaches and assembling places, for the passage of the troops, and for the lodgement of sufficient number to protect the batteries from sorties.

From these data will be perceived the necessity for giving such a direction to the approaches, which are formed in zigzags, and to the parallels, as will secure them from enfilade; and these works will be more or less in proportion to these considerations, to the size of the fortress, and strength of its garrison. (See 'Plans of Attack.')

It is usual to lay down a system of Attack in three parallels, the first at about 600 yards distance, the second at 300, and the third on the glacis; but it should be borne in mind that this is only to give *an idea* of the mode of carrying out the general principle under ordinary circumstances, and not as a fixed rule; for the siege of a place garrisoned or supported by several thousands of men, in fact by a small army, with its environs exposed to its fire for a considerable distance, may require parallels and support from 800 to 1200 yards off, and to be much more numerous and irregular than the three defined parallels above described, as it would be impossible in that case to establish yourself at once so near as within 600 yards, while in proportion as the force of the place is reduced, the operations may be diminished down to the minimum of the single breaching battery.

It may be mentioned here, that a large place strongly garrisoned, however inferior the fortifications, is far more difficult to take than a small one, however complete and perfect its works.

There are many reasons why this should be the case.

1. It is difficult to conceive a case where such a place could be completely invested, on account of the great extent of encampment out of gun-shot round it; every part would be weak, and liable to be attacked by the concentrated force of such a garrison.

2. The space at the disposition of the garrison would be so large, that every part of it off immediate duty on the front of Attack would be quiet and undisturbed.

3. The different fronts would approach nearer to straight lines, and their works probably cannot be enfiladed; or if an angular or salient point be selected for Attack to give that advantage, that very salient would probably afford convenient position for strong and multiplied interior retrenchments.

4. Every sortie becomes a battle of armies; and any error in resisting one may lead to a great disaster.

5. Abundant supplies of artillery and means can be drawn in succession, as required, from the many fronts not attacked.

6. Retrenchments may be formed in succession; for even trifling intrenchments

will be very efficient when on a small front, backed by strong forces, and perfectly secured in flank, where the assailants advance from confined trenches, subjected to heavy vertical and other fire.

On the known advantages which even a few slight works, on a tolerably good position in the field, will give to an army of very inferior force, it may be conceived how strong must be one protected by any thing of the character of permanent fortification.

Subject to the above-mentioned caution, we give plans of the regular system of Attack, as laid down by Vauban, and never altered since, as the best *illustration* of the nature of the principal operations.

On referring to recorded accounts of Sieges, it will be found, that against powerful garrisons the besiegers have usually under-estimated the required works, and have experienced the necessity, as they proceeded, of obtaining more support, and at greater distances than at first intended: this error has very probably arisen from the impression left in the minds of the Engineers by the precise form and proportions given in Vauban's Diagram. An unnecessary amount of extra work has, from the same cause, (of adhering to fixed rules, instead of attending to principles,) been frequently applied in the siege of small places; but the evil in that case is not so apparent.

PRINCIPLES THAT MAY SERVE TO GUIDE THE DETERMINING OF THE FRONT FOR ATTACK.

As regards *natural causes:* the fronts of a Fortress are usually deemed *unattackable* by siege operations when situated on a steep rock exceeding 40 or 50 feet in height. Also those surrounded by water that cannot be drained off, or by marshes; or whose front, on which the approaches must be carried, is seen in flank and reverse by ground occupied by the garrison in accessible situations, having works on it which cannot be silenced; or generally in a re-entering angle.

The Attacks of Fronts are *very difficult* when the approaches must be carried over rock or very stony ground, or among roots of trees, or in a very wet soil, particularly where the natural inclinations will not admit of a free drainage of the trenches.* Also when descending towards works that are on commanding elevations; or approaching them on a lower level, not being in the same plane; or when the approaches must be carried across a narrow confined space presenting a smaller front than that of the place.

As regards the nature of the works: the difficulties to the progress of the besiegers may be greatly impeded when the works are countermined;—where the ground to be passed over may be inundated;—where the front is in one very extended straight line, or nearly so;—where the ditches are cut out of solid rock;—where the flanks have casemated guns;—the revetments en décharge;—with ditches that by means of sluices can be inundated and dried at pleasure;—or where there is a succession of lines of works, each requiring close breaching batteries;—or where the ground and buildings immediately within the front are very favourable for being made into strong retrenchments; for, generally speaking, the nearer the works of defence, whether permanent or temporary, are to the Body of the Place, the greater obstacles will they prove to the besiegers.

Circumstances favourable to the Attack are of course the reverse of the above; also where the ground to be passed over presents much or occasional cover, either from its inclinations or from artificial objects, as buildings, mounds, trees, enclosures, &c.

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* Drainage of all parts of the trenches is very necessary, even in dry soils, to prevent the effects of rain alone.

Ground rising gradually in one plane to the parapets of the works is favourable for the besieger.

It is advantageous to carry on Attacks along one bank of a river, where you have entire possession of the other bank, on which batteries can be placed to take the front of attack in enfilade or reverse, and particularly if that other bank is high and commanding.

Sometimes, a front that is not absolutely the weakest may be selected for the Attack, from some adventitious circumstances of advantage on other accounts, more than counterbalancing that consideration. As for instance, there may be peculiar facility for bringing up all the necessary supplies of artillery and siege stores on that side, by some navigation or favourable roads, or the army may be more advantageously circumstanced by that selection, for covering the operation and securing the communication with the dépôts from whence the supplies are drawn.

PREPARATIONS FOR OPENING THE TRENCHES.

1. Besides the collection of the regular Dépôt of Stores,* there are a vast number of materials to be provided in the country itself, and usually from the neighbourhood of the fortress; they comprise

Platforms, Sleepers, and Planks.	Hand barrows.
Splinter-proof Timbers.	Ballast baskets.
Trestles or other materials for Bridges of communication, large or small, &c.	Fascines.
	Gabions.
	Pickets and Mallets, &c.

The greatest diligence must be used in collecting these in sufficient quantities, from the commencement of the investment; or earlier, if a navigation or other means of transport shall be available for bringing up such materials from a distance.

The following will shew the exertions necessary in order to be duly provided with such materials, with reference to such an Attack as is given in Plates I. II.

In the Attack of a Decagon, as given in Plates I. and II., supposing ten days are allowed to prepare the following materials, as *about two-thirds* of the total quantity, before ground is broken, it will take 870 men per day, exclusive of non-commissioned officers and contingencies, not reckoning about 400 men employed at the same time in collecting brushwood for gabions and revetting fascines, or those on escort duty, with upwards of 100 carts and horses collected to transport these stores, or materials, to their respective destinations.

MATERIALS.

Trench fascines	5 ft. × 10 in. diam.	9,500
Revetting do.	18 ft. × 10 in. diam.	3,000
Sap gabions	2 ft. 9 in. × 1 ft. 8 in. ext. diam.	13,000
Battery do.	3 ft. × 2 ft. diam.	1,500
Platforms, gun and howitzer	18 ft. × 12 ft.	66
Ditto, mortar	8 ft. × 8 ft.	20†
Splinter-proofs } for magazines	10 ft. × 6 in. × 6 in.	1,000
Cap and ground sills } for magazines	15 ft. × 6 in. × 6 in.	100
Pickets (4-feet) for fascines		38,000
Fascine trestles		100

* During the progress of the siege, dépôts of materials, tools, and stores are formed in different parts of the trenches, and are kept supplied with every article required, by the working parties, and sometimes Guards of the Trenches, whenever they come on duty.

† The entire number.

TOOLS.

Adzes	25	Pickaxes	15
Axes, felling	50	Saws, hand	160
„ broad	20	„ cross-cut	20
Bill-hooks	850	„ pit	15
Crow-bars	10	Spades	15
Fascine chokers	35		

With regard to Fascines and Gabions, it is impossible to over-estimate the great advantage of an ample supply.

A Sapper with gabions can cover himself from view and from musketry completely, in about 15 minutes; and partially from case-shot, in 30 minutes, in ordinary soil, after the gabions are placed.

With a fascine of 10 inches diameter he can obtain the same cover in 45 minutes; and without either, he will require 50 minutes.

Independently of that advantage, the work is more easily and regularly executed, and the parapets in better form for defence, by the employment of these means.

It would be almost impossible to procure a supply equal to all the demands that would follow on an adherence to the rules and drawings laid down for Sieges in most elementary works.

There are many applications of fascines, particularly to the parallels, thus defined, that probably *never* have been used in an actual siege, such as the crowning of gabions with a triple, or even a single row, &c. Tracing fascines in a first parallel and approaches are, it is believed, seldom used, although certainly they are of advantage, and might, after a nearer parallel is established, be taken up, and the materials used again.

In a Siege, the difficulties and losses will in a peculiar degree be increased with the length of time occupied in the actual operation; every effort therefore is made to proceed as rapidly as possible after the first commencement.

Hence it is better to delay the opening of the trenches till the preparations are in so forward a state as not to occasion any liability to subsequent delay for want of materials, or of other means.

2. Before the opening of the trenches, the ground on which each part of the first night's work is to be executed must be *thoroughly* defined and understood.

The first course is to construct a plan, on which, by distant observation and measurement, every particular feature and object must be shewn in its true relative position.

Much inaccuracy will occur by trusting to the ordinary rough field-sketching, by pacing and pickets, &c., &c.; therefore it is necessary that the particulars should be accurately defined by good surveying instruments, and Officers well experienced in the kind of operation, and who will be *responsible* for the work.

However well this may be done, and however minute the observations made from a distance on the guides to be afforded by particular objects and marks, they will not be sufficient to enable the Engineers and Sappers to lead, and place the covering and working parties in their proper positions on a dark night; and the consequence of trusting to them would be inevitable confusion, and many errors in the works.

In addition therefore to that knowledge, a most perfect acquaintance with the locality itself must be obtained, by effectual investigation of every part by the Engineers personally on the spot during preceding nights, and such marks even *fixed* as can be done without danger of their being discovered by the garrison.

For this object as well as for many others that are very desirable, the garrison should

be kept close to its walls, (if possible, within them,) particularly by night, from the first investment.

There will be a struggle at first, and perhaps continuously, for the advantage of extending the outposts to the front by both parties, and if persevered in with energy, of which it is well worthy, will be resolved at length into that of absolute power, which will probably be, that a garrison of moderate strength may be kept very close to its works every night; and in the day, small parties and stragglers will be able to be out to from 300 to 600 yards from the place, if the environs for that and greater distances are well exposed to the fire from the fortress.

It is usual to attempt to deceive the garrison, or, at least, to leave it very doubtful as to what part it is intended to attack. If that can be done, it will be of advantage, but will require many additional precautions, such as making the same efforts and demonstrations throughout on other fronts that may be considered liable to be attacked: there would be no use in carrying on similar pretences against those that are clearly of very superior strength.

The last night before opening of the trenches, the most complete recognition of the ground to be traversed and occupied should take place by the Officers and Sappers who are actually to conduct and direct, and every mark placed that can be without risk of discovery, which, it must be recollected, may be made by any single enterprising individual from the garrison getting to the ground by stealth during the night or day.

3. There is a system and peculiar order to be observed by working parties, in opening ground under the guns of a garrison, that requires to be understood by every man in the army, more particularly as they are performed in the night, and in perfect silence. Hence it is most desirable that the soldiers should by corps be exercised in the different operations that they may be called on to execute.

1. In practising ordinary trench-work, with and without fascines or gabions.
2. The system of work in batteries.
3. The nature and extent of the different tasks that will be considered the complement of one tour of duty in trench and battery-work for night or day.

It will not be necessary that the soldiers should do much actual work in these exercises; in many of them, none; but that they should become thoroughly acquainted with the forms of proceeding by good instruction, and with what they will have to execute, by specimens shewn them.

They should also have such acquaintance with the amount of labour required for each defined task, by seeing a few Sappers execute them or otherwise, as may satisfy them that they are by no means hard, but can be readily performed by a little exertion.

Another good result may be derived from these exercises if conducted with due formality, in attaching more military effect to the duty than is usually now the case.

On this subject it may be useful to add a few remarks under the head of

MILITARY LABOUR.

It is a matter of some importance to ascertain and define the value of military labour, and the mode of applying it to the greatest advantage.

It may be affirmed that the service that may be rendered in a campaign, by zealous and well-regulated work to be performed by the troops, is not sufficiently appreciated, nor sufficient pains taken to encourage and enforce it.

The ordinary day labour of soldiers is inferior to that of any other class of men; and there are many reasons to account for it.

1. Soldiers have no inducement to work hard; it is not to procure them a livelihood; they have no encouragement for exertion, or punishment for indolence.

When set to work, it is not uncommon for a soldier to remark, that he enlisted because he did not like work.

2. Commanding Officers have a great dislike to their men being so employed, as it wears out their clothes, and is considered to tend to their being less well set up in the ranks.

3. Officers and men are apt to consider it as an extra and unprofessional duty.

It is very desirable that these feelings should be corrected, and that the army should become sensible of the advantages to be derived from laborious exertions with the pickaxe and shovel, as laid down in the Queen's Regulations, but commonly little attended to.

Let an army once take the field well provided with Engineers and Sappers and a good dépôt of Intrenching Tools; let them never neglect, when near an enemy, to work at improving their communications, bridges, &c., strengthening outposts, and intrenching themselves with judgment in every position in which they can be attacked; and they will soon find the advantage it will give them in a day of action,—so great, that a vast deal more stress will be laid on the system than is now attached to it.

If any Officer who has seen much service will recall to mind the days on which he has been engaged, and conceive the force which received the Attack, (whether his own or that of the enemy, but particularly his own,) with such redoubts and works and cover as could, with the means which will be found suggested under the heads of Intrenching Tools, Stores, &c., have been thrown up even in twenty-four hours, he will at once perceive how far superior his situation would have been, and with how many more chances of success.*

From the commencement of the Duke of Wellington's campaigns in the Peninsula and Belgium, Vimiera—Talavera—Busaco—Fuentes d'Onor—Albuera—the Nive, and lastly, Waterloo, each presented circumstances whereby the position of the British Army might have been greatly improved by a timely and judicious application of intrenchments, such as there was time for: many casualties might have been prevented, and success made more certain; and there were innumerable situations where such supports would have been of great value to outposts and detachments.

It would not be an uninteresting study to take the plans of each of the above positions, and project what might have been done in each with reasonable means at hand, by those who are in the habit of employing them.

The Lines of Lisbon afford a splendid instance of the use of intrenched positions.

A proof of the manner in which the principle will force itself into attention during continued campaigning may be drawn from the first military authority extant.

During the earliest campaigns in the Peninsula, the Engineer Department consisted of a few Officers and a very small detachment of the ill-organized Corps of Royal Military Artificers, without any intrenching tools or stores.

In 1811 and 1812, although there were far from superabundant means of transport

* History is full of examples in proof of this.

The gain of the decisive battle of Pultowa, in which Charles XII. was defeated for the first time by the Russians, was attributed to a few very imperfect redoubts, thrown up by the latter during the preceding night.

In the hard-fought battle of Borodino, in 1812, the redoubts are said to have occasioned immense loss to the assailants, although of so weak a profile that at last the French cavalry made its way into them.

with the army, 100 mules were allotted, by the Duke of Wellington's orders, for the conveyance of a small dépôt of intrenching tools and Engineers' stores. In 1813, a pontoon train was organized and added, and some companies of Sappers joined from England, but unfortunately not long before the Peace of 1814.

In 1815, with the army in France, companies of Sappers, and dépôts of intrenching tools, &c., on a much larger scale, were attached to each division of the army.

Notwithstanding this commanding testimony to the value of preparation for military labour in the field, and the importance attached to it by that paramount authority, there is every reason to believe that the same apathy as heretofore manifested with regard to the exertions to be used in such operations would still be found to continue in the Army, and it therefore cannot be too strongly deprecated. Whatever may be the sentiments or efforts as regards ordinary work, it is impossible to stir a step without it in a siege, or to evade the necessity for exertion then; still we can state from experience that in the Peninsula, the latest service we have of the kind in Europe, the amount of work executed in the trenches by given numbers of men in given times was very far less than what it might have been; and even that was performed in a listless manner: the working parties were handed over to the Engineers; their own Officers rarely interfering to promote the operation, unless in cases of a Sortie or Assault, when they would immediately resume their habitual energy.

It is the duty of the Engineer to arrange the men and tools, and to give every necessary direction and attention for the labour being properly applied; but the Regimental Officers should be entirely responsible for the quantity of work performed; and it should be held equally discreditable to a corps to be deficient in exertion in that branch, as in the neglect of any other duties.

*The result of experience shews that the spirit and efficiency with which any corps conducts itself in working parties is no mean criterion of its general order and discipline.**

The consequence of want of exertion in working in the trenches is very serious, independently of the loss of time in the operation, when the difference of a day or two may lead to success or the reverse, and affect the whole campaign: a larger number of men are employed and exposed, and this severe duty comes oftener on the men; for it is manifest that if 500 men could by proper exertion do what you are obliged to bring 600 men for, 100 men are employed in the trenches throughout the siege more than necessary; and this is not an exaggerated proportion to allow for what has been the nature of performance in such duties.

It was a common practice, and one very injurious to this service, as shewing the injudicious view taken of it, namely, that of keeping the roster for it by detachment, according to the precise strength of the regiments, and not by corps, as it should have been: the consequence was, that working parties of a few hundred men were composed of officers, non-commissioned officers, and men of various different regiments. It may be conceived how little order or discipline could be kept up in such cases, particularly by night, and how little these bodies imagined it to be necessary: as a natural result, many of the men made no scruple of evading the work,

* In a Siege, more than in any other service, there are opportunities for individual acts of intelligence, spirit, and exertion; and such acts may be of very great advantage, whereas in the Field they are only instances of a display of courage.

Hence it would be peculiarly desirable and politic at sieges to establish a system of rewards for such acts.

In the French Service it is quite usual to order a gratuity to the individual or party, of money, if consisting of Privates or Non-commissioned Officers: Commissioned Officers obtain promotion.

Perhaps medals might be a better reward than money.

which was done with impunity, and the rest worked very indolently. This practice should be abandoned, and all working parties furnished by corps, each with their own Officers, even although it may make a little inequality in the proportions according to their precise strength.

The most advantageous mode of applying soldiers to Field or Siege-work will be, where it is possible, by tasks; which will be described hereafter.

With reference to the labour of soldiers in the field in general,—there is one consideration that must not be forgotten in estimating the amount of work that may reasonably be demanded from them in given times, which is, that during the hardships, deprivations, and fatigues of a campaign, they have not by any means the physical powers of an ordinary labourer living at his own home. Their task should be calculated accordingly; but whatever it may be, it should be executed with alacrity and spirit.*

ARRANGEMENTS PECULIAR TO THE ENGINEER DEPARTMENT.

The whole of the Engineer department will encamp at or near the Dépôt.

The Ordnance Assistant-Commissary will have charge of the office and all stores, and will be responsible for their care and maintenance.

He will have to assist him, the Clerks and Conductors of Stores, and a small detachment of Sappers.

The tools and stores of all sorts will be kept in order and readiness to be delivered out at a moment's warning, during night or day, by the Sappers of his detachment on duty.

He will send a Sapper daily to the trenches, to collect all the broken and spare and dispersed tools, with the assistance of a few men from the working parties, which the Officer on duty will give him.

The broken tools will be immediately repaired by the Smiths and Carpenters employed for that purpose.

The fascines and gabions must be regularly piled, and not allowed to be removed except for the works.

The sand-bags will require particular attention, to prevent their being purloined for many purposes to which they can be applied; as will also the axes, hatchets, and bill-hooks.

If they should not have the advantage of any other protection, the stores and tools will be enclosed by a rope fixed to picketing posts, and no one allowed within it by the sentinel but parties having business there.

The Artificers, Fascine Makers, &c., must be responsible for the tools delivered to them, of which a record is to be made.

The Ordnance Commissary has charge of the workmen in the Dépôt.

His Clerks will enter regularly an account of receipt, issue, and expenditure of stores; of all persons attached to and employed by the Engineer department; and of their pay, either for day or task-work.

The workmen should be paid every evening.

The Carpenters are divided into numbered brigades of four in each.

The Sappers into brigades of eight.

The Miners into brigades of four.

As soon as parallels are entirely established, and safe from being carried by sorties,

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* It is very desirable to provide some regular organized means by which the different parties could always obtain *water*, without having to send numerous detachments out of the trenches, altogether with imperfect means, for bringing it in small quantities.

small dépôts are formed in them, where the Officers of Engineers will be able to send readily for any article required. A guard is placed over them, with at least one Sapper; and the platforms (among other things) may be collected there by degrees, brought in by the working parties, to be in readiness as soon as required, and from whence they will be less liable to be mixed than when brought at once from the main dépôt to the batteries.

The following will be the dimensions and prices* paid for the fascines and gabions, &c., brought in by the different parties.

The prices are calculated on the supposition that the parties find their own materials, where they are in plenty and near at hand.*

			ft.	in.
Large Sap Gabion, ready for stuffing, 6*s*. each.	Diameter (from centre to centre) of pickets		3	6
	Height of the wattling		5	0
	Distance asunder of the seventeen pickets		0	8
Common Gabion, 1*s*. each.	Diameter		2	0
	Height of the wattling		2	6
	Eight pickets or stakes	Length of each	3	0
		Diameter . from 1 to	0	1½
Battery Fascines. 18 feet, 2*s*. 6*d*. 12 feet, 1*s*. 10*d*. 9 feet, 1*s*. 5*d*.	Length		18	0
			12	0
			9	0
	Diameter 10 inches, or circumference		2	7
	Distance of the gads asunder		0	9
Fascines for stuffing the large Sap Gabion, having a Stake or Picket within each, 1*s*.	Length		5	0
	Circumference		2	0
Tracing Fascines (Fatigue work.)	Length		5	0
	Circumference		2	0
Fascine Pickets (Fatigue.)	Length not less than		3	0
	Circumference, at thick end, from 3 to		0	5
Gads (Fatigue.)	Length not less than		4	6
	Circumference, at thick end, from 3 to		0	5
Stakes for the Horses or Trestles for making Fascines on.	Length		5	0
	Circumference, about		0	10
Horses or Trestles all ready, the 6 for an 18-feet Fascine, 8*s*.	Distance asunder		2	6
Fascine Mallets, (of hard wood,) 1*s*. 6*d*.	Length of the head . . . . . 8 or		0	9
	Diameter of ditto . . . . . . 5 or		0	6
	Length of the handle . . from 3 to		5	0
Each Gun Platform,† 10*s*.	3 Sleepers.	Length of each	14	0
		Width	0	5
		Thickness	0	6
	1 Hurter.	Length	8	0
		Width	0	8
		Thickness	0	8
	14 Planks.	Length of each	10	0
		Width	1	0
		Thickness	0	2

* These prices will of course be liable to variation from localities: those given above are taken from memoranda of Peninsular Service.

† These platforms are of the lightest advisable description, and will weigh less than those given in the list, p. 73. Whatever changes may occur in the construction of platforms, &c., &c., the above, as the result of much experience, have been retained as valuable precedents, though they should be but partially applied.—*Editors.*

			ft.	in.
Each 13 or heavy 10-inch Mortar Platform, 8*s*.	3 Sleepers.	Length	7	0
		Width	0	8
		Thickness	0	8
	11 Sleepers.*	Length	6	0
		Width	0	8
		Thickness	0	8
Each 8-inch Stone or other light Mortar Platforms, 7*s*.	12 Sleepers.	Length	8	0
		Width	0	6
		Thickness	0	6
Splinter-proof Timbers, for Magazines, 1*s*. 6*d*. each	Length	from 9 to	12	0
	Width	from 4 to	0	10
	Thickness	from 6 to	0	10

Carpenters, for pointing, trimming, and cutting pickets to their proper length, may be allowed 1*s*. per 100, the pickets being brought in for them.

The Sappers and Men of the Line attached to the department are paid according to the Regulations.

The Fatigue parties from the Line, for collecting materials in the rough and in bulk, and the ordinary working parties during the siege, are not paid.

The Serjeant of the Dépôt will receive these stores, and give an account regularly of the quantity delivered to the Clerk, to be entered in the books, as well as all issues.

All the articles which are not well made and nearly according to the prescribed dimensions will be rejected; for those accepted, a receipt will be given as they are brought in.

Gabions,† to be received, must be strong, stand firm, and upright, and the work close;—a few rows of wattling, well bound together by at least four gads at top and bottom; and in no part of their length or diameter varying more than 2 inches from the proper dimensions.

Battery Fascines,† to be accepted, must be straight and cylindrical, closely bound with good thick gads not more than 9 inches asunder, and the knots well tied and in a line; the length to be exact, and the thickness in no part to vary more than one inch from that prescribed.

DIRECTIONS TO THE OFFICERS AND ENGINEERS, AND THEIR DISTRIBUTION.

The Second in Command will be Director of the Attacks. He will be obeyed by the Department in all parts, and must pay his particular attention to preserve regularity in the trenches, and more especially to the laying out of all new works.

The Brigade-Major and Adjutant will keep in order the Returns, Rosters, Official Letters, &c., and have particular charge of the Sappers: they will occasionally be able to visit the trenches to assist the Commanding Officer, or for his information.

A certain number of Officers will be divided into numbered brigades of two in each.

The unattached Officers may be in the first instance employed in setting to work the Gabion and Fascine Makers, and in arranging the Platforms, or they may be put as supernumeraries to the Brigades.

A nominal list will be made out of the distribution of the Officers and Sappers.

The hours of relief will be 4 P.M.,—Midnight,—and 8 A.M. Or, 5 P.M.,—3 A.M.,—and 9 A.M., as found best, to which the Officers must make it a point to be punctual, particularly for the afternoon relief. There should be some means taken

* Used as planking; they were unnecessarily thick.

† See 'Gabion,'—'Fascine.'

of fixing the time by signal or otherwise, once in each twenty-four hours, for the whole encampment.

The Officers of Engineers must pay particular attention to the different directions for carrying on the works, which will be given out by the Commanding Engineer. They will recollect that the main object in a Siege, where the new work is generally commenced at night, is *arrangement;* upon that point too great a stress cannot be laid; they must therefore use their utmost exertions to preserve regularity and system in all the operations. It is better to delay half an hour, or even an hour, in commencing work, than to begin in confusion; they must call upon the Officers of the working parties to enforce their directions, and to encourage the greatest exertions on the part of the workmen.

The Commanding Engineer's daily order, given at 2 P.M., will make every one acquainted with the works to be executed during the ensuing twenty-four hours. The Officers must cause their Sappers to see every article they will require prepared in time; that is, tools or stores laid out, and tracing lines, measuring rods, &c., prepared, and the Senior Officer of each Brigade will order the arrangement of his party.

They will report particularly in writing to the Commanding Engineer the good conduct of any of the Sappers and Miners, as well as any instance, if such should occur, of misconduct of any kind, or of want of spirit, exertion, or ability.

The Senior Officer of each Brigade will, on his return from duty, send in to the Office a written account of the extent of work performed, with remarks on the conduct of the working parties and of the corps they were furnished by, as well as a detail of the occurrences of his relief; such as, of Sorties, of the nature of the fire from the enemy, and of our own, with their apparent effects; the works the enemy may be carrying on, as far as he can perceive, &c. These Reports, revised by the Director, will be copied into a book or journal, kept at the Royal Engineers' Office for that purpose by the Adjutant.

They will give certificates in writing to the parties for all task-work; for which purpose they will find it convenient to go prepared with everything written on small slips of paper but the quantity of work, which can be filled in on the spot. For the Sap, and such works, the payment will be made on these certificates.

OPENING THE TRENCHES AND FIRST PARALLEL.

It is usual to undertake, on the first night of opening the Trenches, the entire of the First Parallel, or protective position, and its approaches. See figs. 2, 3, and 4, Plate I.

We will assume in this case that this Parallel is to be at about 600 yards from the salient angles of the covert-way, with two or three approaches, as shewn in Plate I.

The 600 yards distance for the First Parallel is from the main works of the place, without regard to any detached works, unless they are large; it is considered in ordinary cases the best, because beyond the effect of much injury from grape shot or musketry, or of any serious sorties from a garrison of moderate strength; and because it is about the extreme distance for very steady howitzer practice.

The Parallel is extended in length 50 or 60 yards beyond the prolongation of the extreme faces of the works of the front to be attacked, and turned round at the ends as a protection to each flank, or should be finished by a redoubt or palisading, where there is much to apprehend from sorties, if the garrison is strong. See Plate I.

The approaches in zigzags should be directed to a point at least 30 yards outside of the extreme parapet or covered way of the garrison from whence fire could be directed on them, in order to avoid effectively not only enfilade but ricochet shot.

In section the parallels are 10 feet wide, including the front banquette, and the

approaches 8 feet without a banquette; each of them having an average depth of 3 feet, with a slight fall from front to rear for drainage, and which also affords some advantage in defilading the trench, or improving its cover.* Plate I. figs. 2, 3, 4.

Means for getting easily out of parallel and approach to oppose sorties, particularly from the former, should be afforded.

The interior slope and top of the parapet of the parallel is shaped with the shovel, so as to give the most cover with a proper height (4 feet 2 inches) to fire over.

In great Sieges, or Attack of Fortresses of the 1st and 2nd orders, the width of the parallel will require to be increased, and in very small ones may be reduced.

The approaches forming the roadways into the trenches could hardly be reduced under any circumstances; and those of the first entrance, that is, up to the first parallel, will probably be better of greater width, to give more freedom of passage.

It will be an object to endeavour to conceal from the garrison the *time* of the opening of the trenches, because if the first night's work can be executed without interruption, the operation will be much facilitated, and many casualties saved.

This is to be done by keeping the assembling of the troops for the purpose, and other demonstrations, as little perceptible as possible.

The Covering† and Working parties will be given from the nearest encampment; the latter will assemble in due time at the Engineers' Dépôt, where the tools and materials will have been laid out in readiness for them.

To preserve ordinary appearances, the Pickets usually employed to confine the garrison to their works will proceed in their accustomed manner and time: they will form part of the covering party for the night.

Immediately after the darkness of the night is sufficiently complete to *insure* the impossibility of observation from the enemy, the Engineers, aided by their Sappers, proceed to mark out, as rapidly as they can, the lines of parallel and approaches.

No saving of time, however, is to justify any degree of inaccuracy; they will therefore have considered deeply, and by as many actual trials as possible, in recognizing and fixing the localities, how to secure the opening of the trenches with accuracy and rapidity.

As soon as the necessary given points shall be found, the especial Covering party for the protection of the work will be led out to their positions by Officers of Engineers.

The main bodies will be posted in line about 100 yards in rear of the parallel that is to be formed, and in the intervals and on the flanks of the approaches.

If any part of it can be placed under cover of rising ground, buildings, &c., advantage will be taken of the circumstance.

Strong advanced Guards are detached to about 100 yards in front of the parallel; they will remain collected in small parties; posting in their front again, a line of Pickets near enough to prevent any one passing between them unobserved.

To prevent mistakes and false alarms, the working parties must be made acquainted with the fact of a portion of the covering parties being in their front.

In laying out the lines, the principal points are first marked with pickets made visible by bunches of straw, or white paper, about their heads; and the intervals

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* The rear of the trench is much the most exposed to the fire from the garrison; although not actually in view, many casualties happen there from shot dropping in immediately over or through the top of the loose earth parapet.

† The protective force has usually been denominated in the British Service "*the covering party*," which may be correct previously to the construction of any of the trenches; but subsequently "*guard of the trenches*" would seem to be more appropriate, and is more in accordance with the practice of other nations.

defined by straight lines of white tape,* which is to denote the actual line of the excavation.

Each man of the working party carries a pickaxe and shovel, and a tracing fascine (if the latter be employed); the fascine on the shoulder that will be towards the enemy as he files into his position to work.

When the lines for the works are sufficiently marked out, the Brigades of Engineers, with their Sappers, lead out the working parties direct to the several points from whence each is to be arranged.

When the head of the file reaches the fixed point from whence that party is to commence, he is halted, and his fascine taken by a Sapper and laid parallel to the white line, and at 18 inches from it; the next man files up, and the same is done with regard to his fascine, and so on till the whole are placed, every man in succession sitting down on his fascine, which thus marks the length of trench allotted to each.

There must be no wavering, or chance incurred of misleading the covering or working parties to their precise points in the nearest direction, and by that which is most clear of obstructions: if at all necessary, men with dark lanthorns will be fixed at particular points, essential for obtaining the proper direction.

Lanthorns for this purpose may be fixed or hung on a disc of tin or wood, to form a screen on the side of the garrison, and must only be intrusted to a N. C. Officer of Sappers, or some man who can be thoroughly depended upon for steadiness and intelligence, to prevent its being observed by the enemy. The light should be small, and not allowed to strike on any *near* object.

When the *whole* are placed by *all* the Brigades, and not till then, the word is passed, or some signal given, (that cannot be perceived by the garrison,) to commence work, which is then to be pushed on vigorously; but, if still undiscovered by the enemy, with as little noise as possible.

Should no tracing fascines be employed, the proceeding is carried on in the same form; but other means must be adopted for placing the men at a proper distance asunder.

The first night's work is necessarily a short one: suppose the excavation actually to commence at nine or ten o'clock of a summer's night,† there will be probably five or six hours available in the dark, and about three more after dawn.

It is usual to anticipate but a small portion of work to be executed on this first night; each workman having 5 feet of length of trench, and the given depth of 3 feet to excavate, only 4 feet in width is the quantity laid down as reasonable to expect, being less than 2¼ cubic yards. This should be considered as the very minimum, even in unfavourable soils, (not being rock or swamp,) or when the weather is particularly bad, or the party under serious interruption from the enemy; it is a very trifling amount of work for a man to execute, and half of it will be done by him voluntarily within the first hour, in order to gain cover;—so small a result leads to the space obtained being most confined, and inconvenient to contain the guard as well as the workmen in the morning, besides that many other advantages would arise from greater energy in the first night's work.

Indeed, it is on record that the excavation for parallel and approach is frequently completed during the first night, leaving only the shaping and putting banquettes for the next party.

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* In Foreign Services a light-coloured rope is usually employed; white tape, or long strips of linen, however, of from 1 to 2 inches broad, as used in our Service, is particularly conspicuous in the dark, very portable, easily procured and managed, may be occasionally saved, washed, and used again, and is considered altogether preferable.

† Latitude 38°.

In reference to Siege and Field-works, the quality of the soil is sometimes divided into three classes.

1. Light, and to be worked with the spade and shovel alone.
2. Requiring one pickaxe to two shovels.
3. Requiring one pickaxe to each shovel, which may be deemed the hardest, not including rock or large boulder stones.

The third case, consequently, would require double the number of men to execute any given quantity of trench-work that the first would; or at given distances asunder the men would do half the amount of excavation.

A man working by day for ten hours could excavate in the light soil, and throw out earth with the shovel in such a trench, to the amount of about 10 or 12 cubic yards.

A *complete parallel* 10 feet wide by 3 deep, at the length of 5 feet per man, would be less than half that quantity, that is, little exceeding $5\frac{1}{2}$ cubic yards, and should be done with tolerable ease in light soil during the first night; or, in more difficult soils requiring occasional use of the pickaxe, 8 feet in width (under $4\frac{1}{2}$ cubic yards) might be completed.

Either of these quantities, therefore, according to circumstances, might be expected for the first night's work, except in peculiar cases of difficulty.

During the night, and particularly just before perfect daylight, the men must clear away the upper step of the banquette or berm of 18 inches in front of the excavated line, and lower the top of the parapet, throwing the stuff in both cases well to the front, in order to leave space for the earth subsequently to be excavated, without the necessity in the day of exposing the workmen to the enemy's fire.

All these arrangements will be much easier, and the entire operation more readily and cheerfully performed, if the whole of the troops understand thoroughly, by previous practice, what is required, and what is its utility.

Besides the precise number of workmen calculated to fill up the entire space, there is always added a good reserve (about $\frac{1}{20}$) to allow for any deficiencies when laid out, and for casualties, &c.; and even should that reserve not suffice, the General Officer commanding in the trenches orders out what may be necessary from the pickets, in reserve, in camp.

The working parties are laid out from the front, that is, along the parallel first, and thence to the rear along the approaches; so that any deficiency may affect the rear and part most distant from the enemy, where it is easier to be provided for.

It must be expected that there will be various spots and places to cross that will present more difficulty and require more skill to complete than the rest.

1. Water-courses and drains: these must not be interrupted, and will require pipes or openings made up of planking or other means to leave a free passage; otherwise, it will be necessary to open them subsequently with much labour and difficulty.
2. Hard roadways, perhaps paved.
3. Buildings, walls, ditches, shrubberies or trees, &c., &c., &c.

To all such places a few Sappers, or of the regular men attached to them, should be appointed, who will be properly provided with means, and will understand how to complete the line over such obstacles. Where the entire of the soil is of rock or bad swamp, it may be deemed impracticable to carry on siege operations over it, in front of a garrison of any power. Such ground may be passed, and even batteries constructed on it,* by the necessary extra earth or materials brought from the nearest or

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* A foundation of two crossed courses of fascines will support any work on a swamp.—*Editors.*

most convenient place, if that part of the operation be of small extent; to assist, the trench may be widened when depth cannot be obtained.

The General in command of the trenches, and the Guard, take the duty for twenty-four hours, and are relieved at mid-day; the Guard being furnished by battalions, if not by brigades.

The working party take the duty for twelve hours, and are relieved usually at 6 A. M. and 6 P. M.; the duty should be by companies at least, but better by regiments: in neither case by mere mixed detachments. If the besieging force be strong enough in proportion to the siege-work to be executed, a more frequent relief of working parties would tend to the more rapid completion of the work; but the arrangements should be such as to give the troops at least three periods out of the trenches, for one in.

The Engineers, Sappers, and men attached, should have three reliefs in the twenty-four hours, and at different periods from the working parties; but they will be well off if they are in sufficient number to have not more than one in four tours in the trenches.

When working parties are tasked, they should be dismissed scrupulously as soon as the task is completed; and more work will be obtained, and with more alacrity and satisfaction to the men by this mode, than by keeping them lingering over the work for twelve hours. There is also a great advantage in getting the work clear of these men for some time before the new party comes in; such interval is most usefully employed by the Sappers and their assistants in arranging the tools and work, and adjusting or completing any part that may be a little irregular, deficient, or exposed: this is so desirable, that when the men work even *by time*, it is well to collect and retire them a full half-hour before the arrival of the new party.

If the working parties have their arms, and form part of the strength of the force for resisting sorties, they must not be dismissed *from the trenches altogether*, till relieved, but will be in that case only withdrawn from the work.

In cases of reliefs, or generally of parties meeting on any account in the trenches, the out-going party invariably halts, and lets the in-coming pass.

Should the opening of the trenches be decidedly discovered even early in the evening, and a heavy fire directed upon it, it can still be forced on by discipline and spirit, and without so much loss as might be expected.

The same precautions must still be taken by the Engineers to insure correct positions and lines, and in bringing the parties up. The only difference in the arrangements will be, that under such fire the workmen commence, each man as soon as placed, in order that he may be sooner under cover.

The result of such a night, however, will be some inaccuracies, and some parts imperfectly completed;—reserves will then come more particularly into service, and there will be more need for the adjustments applied by the Sappers and assistants.

In order to reduce the amount of duty, and the number of men in the trenches, it is the general custom now to make the working parties take their arms and accoutrements,* so as to make up with the guard the necessary number to resist sorties. It is attended, however, with many inconveniences. The arms and accoutrements are a great incumbrance to them, and being laid on the reverse of the trench, are liable to be injured;—in case of a sortie or alarm it is not easy to get these men collected and in order; they become mixed with the guard, and hence arises confusion; nor are they easily brought back to the work.

At all events, however, it is particularly desirable that the parties who first break

* Their knapsacks are left in camp.

ground should not take their arms: they have each two intrenching tools, and perhaps a fascine, to carry; therefore systematic exertions are required from them; and it is unusual at that period to be opposed by any great sortie.

It would be less inconvenient for the morning relief to be armed, as they will have few, if any, tools or stores to carry; they can also take better care of their arms, and may be more likely to want them during the ensuing day.

SORTIES.

In ordinary Sieges, Sorties in much force, made upon the approaches when not less than 250 yards distant,—that is, up to the second parallel and its batteries, or farther,—can seldom be very injurious to besiegers, unless the latter are guilty of great neglect or want of caution, or have very imperfect means of protecting themselves.

The garrison in making a sortie has one advantage, namely, the shortness of the distance to be passed between the first alarm, and being in contact with the enemy; so that if the besiegers are negligent, it partakes of a surprise; but that advantage is to be neutralized by the troops in the trenches being taught always to expect such an attack at any moment, and the measures to be adopted being thoroughly understood.

After the French had made one or two sorties at St. Sebastian with some success on a parallel at about 200 yards distance, the Guard in the exposed part of it were made during the night to sit on the reverse of the trench with their arms in their hands, in expectation of the next, and under instructions to charge the enemy the instant they should be seen on the parapet. This accordingly took place, and it was driven in at once without an attempt at a struggle, and was the last attempt of the kind.

The Sortie is also considered to have an advantage in being covered by the fire from the place; but if it be advanced to any distance from the works, it will probably suffer more loss in retiring to them, than the besiegers will from the artillery of the garrison.

The disadvantages of the troops making the Sortie are—

1. That they necessarily attack a superior force, probably very superior: the ordinary rule is, that the Guard of the trenches should be equal to three-fourths of the garrison; it is seldom, if ever, that a sortie will be of any thing like that proportion, and the far greater number of comparatively small force.

2. That they are under the moral impression that definitively they will be forced to retire; and the only question being *when* that is to take place, they must be inclined to yield to the first spirited attack made on them.

3. In retiring, which it must come to, and necessarily in some confusion, the exposure and consequent loss must be heavy.

4. Every loss to the garrison is irreparable; whereas the supply for the trenches is, as it were, inexhaustible; in other words, the advantage would be with the besiegers in the loss of man for man with the garrison.

It would of course be of vast importance to the garrison if by sortie it could obtain possession, even for a short period, of any of the armed batteries of the attack; but such an advantage is not to be anticipated, unless occasionally, perhaps, in sieges of very large places.

The principal efforts are made upon unfinished portions of work, and the success will be more likely to be effective, if such unfinished part is extensive, and consequently farther removed from support.

A very short possession of parts of the trenches, lined with gabions, may cause much trouble, time, and casualties to the besiegers: the gabions being overturned into the trench, and partially cut, are extremely difficult of removal, thus adding

greatly to the slow process of the Sap, or gradual progress made generally in the near approaches.

The disposition of the Covering Party on the breaking ground for the First Parallel is as follows:

The main body is drawn up in distinct lines, between and on the flanks of the approaches, and about 100 yards in rear of the parallel, detaching strong advances to about 100 yards in front of it, which also remain in compact bodies, excepting a close line of Pickets or Sentries, another 100 yards more in front.

These Pickets must be throughout on the sharpest alert, with their arms always in hand, frequently applying their ear to the ground, in order to be early aware of any movement of the enemy towards them.

If a single man or two should approach to reconnoitre, (which is very usual,) they must allow him or them to pass, and endeavour to make them prisoners without creating an alarm.

The advanced Guards should be always ready and in order to attack any sortie at once; and will probably repel it, unless very strong in force, which is hardly to be expected at that period.

The main bodies in reserve must remain collected and near their arms, and not ranging from the order in which they are to fall in: this may be deemed a general rule for night or day, and at all periods of the siege.

The whole (except the Pickets, who are usually on one knee, or reclining in a position for readily springing into action,) lie down, and if there should be much fire from the garrison, will have to continue so during the time it lasts.

As the day begins to dawn, the covering party takes its post in the parallel.

The construction of the Second Parallel is covered in a similar manner.

Sorties should be always opposed by a brisk advance with the bayonet, and not, even when the parallels are completed and by day, by dispersing the Guard along their parapets. The only men habitually on the banquette are the necessary Sentries to give timely notice of the approach of an enemy. Any other portion that it may be thought right to place at the parapet for receiving the advance by a fire from thence, should be told off and instructed for the purpose; but the greater proportion should remain collected in reserve for a charge. Firing parties are sometimes posted in the advanced works, to act against the defences, and should bring their fire to bear of course against a sortie in their front, although not the primary object for which they are so placed.

Every attempt will be made, by position and movement, to act upon the flanks of the force making the sortie: if it is obstinate, and considerably advanced, it may be thus perhaps more or less cut off; at all events, it will be more speedily made to withdraw, and probably with more loss.

If the trenches are near, no sortie of much force can well be made, except by advancing from the sides collateral to those of the attack; in which case their own flank must be presented to batteries and works in rear, prepared for that purpose.

It will be an object of care and caution not to allow the Guard to follow too far, or to remain out longer than necessary; otherwise it may sustain great and unnecessary loss from the fire of the garrison.

It is much more difficult to regulate the proceedings of the working parties in cases of sortie, than of the guard.

Sorties are sometimes made (particularly by night) exclusively to create alarm and confusion, which must be met by firmness and judgment.

The working parties will in all cases rally and form behind the reserves of the Guard.

If they have not their arms, they will take care to carry away their tools with them;—if armed, that is not to be expected: in the latter case they form as a second reserve to the Guard in the first instance, and are brought forward into action in support of it, if necessary.

In either case they are brought back to their work immediately the ground is cleared of the enemy; and it is a great effort of discipline that this should be done completely and with alacrity.

On night works, to prevent confusion and mistakes, the working party must always be made to understand thoroughly when there is any portion of the Guard in their front.

Commanding Officers of the Guards of the trenches should possess a knowledge of the position and nature of the works and approaches, and make every arrangement for the system to be adopted for their complete protection.

During the construction of the Third Parallel and the works beyond it, many circumstances may contribute to render sorties more formidable or troublesome:

1. A garrison strong in force or in energy.
2. Inefficiency of means for reducing the fire of the place; or for preventing a freedom of collecting and manœuvring bodies of men within the front of attack, particularly in the covert-way.
3. The temporary reduction or interruption of the enfilade, ricochet, or other fire, against the works of the place, by reason of the new approaches masking the batteries previously established, while those operations shall not be sufficiently advanced to be armed with artillery means.

In such cases, small bodies from the covert-way may make frequent assaults upon the heads of the Sap, disable the Sappers and workmen immediately in their rear, and in a few minutes materially injure the unfinished end of the work; for it will be perceived that the Guard of the Sap has no position where it *can* be collected in mass to receive such an attack; on the contrary, it is itself necessarily attacked in flank, and the assailants are very speedily back in their covert-way.

To meet such a system will require a great deal of steadiness and determination. The advanced portion of the Guard must be disposed as compactly as possible, and under precise instructions to be always in readiness, and to charge at once in the most vigorous manner.

Much will depend upon the first two or three efforts: if they are repulsed briskly, and with loss, such attacks will not be frequently repeated; if otherwise, and they meet with a degree of success, a moral effect will be established on both sides, that will tend very much to retard and disorganize the siege operations.

If the garrison shew a disposition to use these vigorous exertions, it may be necessary to run out Demi-parallels, (Plate I.,) or portions projecting from different angles of the zigzag approaches, for lodging and supporting bodies of the Guard, near and in favourable positions.

Steps to the parapets, to enable the Guard to meet or attack the sorties outside of the parallels, must be more frequent, and made with more care. (Fig. 3, Plate II.)

As to the manner of opposing Sorties, as well as in the operations of working parties, previous practice and exercise would be of the greatest service; Officers and men would not be at a loss, but would then understand how to improve every circumstance.

POSITION OF THE BATTERIES.

The first Batteries constructed being those for reducing the fire of the place, are usually placed about 50 yards in front of the first parallel; if for Enfilade, one gun is to be close within the prolongation of the interior line of the parapet of the face, flank, or covert-way, to be enfiladed; and the remainder on the prolongation of the

rampart of the same. Each of these batteries must have its covered approach from the parallel, and its expense magazines.*

They are usually commenced on the night succeeding that of establishing the parallel, and will require great care in being laid out in the proper direction, to produce the proper effect, which in works well defiladed is not always an easy operation.

Should the nature of the works of attack and of the ground admit of these batteries being applicable and efficient as the trenches advance, instead of its being required to establish others in front of the second parallel, it will be very advantageous.

1. Because the work is earlier and more easily executed.
2. The batteries more easily supplied with ammunition and every necessary.
3. The distance is a favourable one for the purpose.
4. The Gunners less liable to casualties.
5. The batteries more retired, and consequently more secure from sorties.

From the period of occupation of the first parallel, every opportunity is taken by night or day of pushing on the zigzag approaches towards the next.

The principal requisites of these zigzags are—

1. To be quite clear from exposure to any degree of enfilade fire from the fortress.
2. To be confined between converging lines, that will not mask the fire of the batteries in their rear.

They are directed on the line of the capital of the work which they are approaching; and the converging lines, above referred to, will be comprehended between the salient angle of the work, and points on the first parallel, about 70 yards on each side of the prolongation of the capital.

SECOND PARALLEL.

The Second Parallel, under ordinary circumstances, is constructed at about 300 yards from the covert-way, and is opened under similar arrangements as described for the first, for even at that distance its establishment can be enforced without much loss; but as the fire of the garrison is more effective, it is desirable to use gabions for it, if possible, and the workmen usually begin to cover themselves as soon as each is respectively placed.

The approaches from the works in the rear must be undertaken simultaneously.

Should batteries against the defences be necessarily attached to the second parallel, they will be also about 50 yards in front of it, and as described for those in rear.

It may be observed, that in general, in proportion as the works of Attack become nearer, the attention of the garrison is so much called to them, that, added to the effect of the fire on the defences, great liberties can be taken in the rear; thus, when the besiegers are on the glacis, little or no notice will be taken of any ordinary proceedings about the first or second parallel, or their approaches.

As the works advance, some means will be required to keep in order and repair the earlier works, but they will be small; their thorough drainage should be always attended to.

ON THE MEANS OF REDUCING THE DEFENCES AND SUBDUING THE FIRE OF THE PLACE.

The works of Attack cannot be carried on nearer than 200 yards of a fortress or fort of the least consideration, unless means are employed to keep down or greatly reduce its fire.

Nor can the storm of a breach, on which a flanking fire can be brought, be attempted without great risk of failure, and almost certainty of very heavy loss.

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* See article 'Battery.'

Hence the cause for reducing these means of defence: and it is well to advert to these principles, because where the necessity does not exist, the formality of the operation may be dispensed with.

There was a striking instance of this in the siege of Ciudad Rodrigo, in January 1812.

The part of the fortress attacked consisted of a revetted line of ramparts, surrounded by a revetted fausse braie, with a ditch and very low counterscarp, the whole unflanked, and the two escarps seen nearly to the foot, from a height within 500 and 600 yards distance.

The time that could be given to the siege, before a relieving army might be brought to raise it, was short.

The project was accordingly to effect a practicable breach by a powerful artillery from the height, and then to storm at once, without approaching step by step in the more ordinary manner.

Twenty-six* 24-pounders were accordingly placed in battery for the purpose, and proceeded unremittingly in the work of breaching, *without paying any attention to the fire of the place*, which had a good garrison and was well provided with artillery.

The French Engineers remarked upon the singularity of this proceeding, but it was founded on good principles.

The fire of the garrison could not check the operation of breaching.

It was not the intention to carry the works of Attack very near the place; although during the operation, a small parallel was, with exertion and some difficulty, constructed on a lower intervening height, to within about 200 yards, *and the breaches were not flanked;* consequently, according to the project adopted, there was no absolute necessity for opposing the fire of the place; and any means applied to it would have been a reduction of those for the more urgent object of breaching.

The above is a very rare case, arising from defective fortification and the pressure for time.

Under all ordinary circumstances of sieges, it is necessary to pay great attention to the reduction of the fire of the place; and, generally speaking, the result of a siege operation, as regards certainty of success, amount of loss sustained, and time engaged in the undertaking, will be dependent upon the efficiency of the means employed for this purpose. If they are abundant, and skilfully managed, the Engineers' progress will be rapid and easy, by day as well as by night; but it may be understood how effective the fire of the besiegers ought to be, when it is brought to mind, that *the fire of the lightest piece of artillery on the head of a Sap will effectually stop its progress during daylight.*

The means employed for reducing the fire of the place are—

1. Enfilading the several lines of rampart and covert-way from guns or mortars.
2. Ricochet combined with enfilade.
3. Direct fire of artillery to ruin the parapets.
4. Musketry brought to bear upon the embrasures.
5. Pierriers, or stone mortars, and royal, as well as Coehorn mortars ($5\frac{1}{2}$ and $4\frac{2}{5}$ inches), when very near.

1. *Enfilade.*

A line exposed to be enfiladed by guns at full charges, within moderate range, cannot be deemed tenable; hence one of the earliest improvements in fortification was

* The number varied from twenty-three 24-pounders and two 18-pounders, to thirty 24-pounders and two 18-pounders.—*Editors*.

to construct the works so as to be *defiladed,* that is, so arranged as that their interior should not be seen: thus they were protected from shot, until Vauban invented the mode of effecting the object by ricochet.

No protection was afforded, however, against the effects of enfilade from mortars, either then or subsequently by the traverses, which were contrived to check the ricochet.

The enfilade by mortars against uncovered batteries is very destructive.

Where fronts are well covered, an enfilading battery is constructed against each face or flank, &c., requiring to be silenced.

Circumstances seldom occur of the whole front being so enveloped by the trenches as to admit of enfilading it generally; but sometimes they are so, and a considerable advantage thereby afforded.

Such a position commonly occurs from the opposite bank of a river to that on which the place is situated, where batteries are constructed to take the entire front generally by enfilade; and many of its lines, consequently, at different angles in reverse.

If not only this advantageous position can be gained, but they can also be placed upon heights from whence the interior of the works can be *seen,* although even at very long ranges, such as 1200 or 1500 yards, as at St. Sebastian in Spain, the advantage is very greatly increased.

2. *Ricochet*

Is a very formidable application of artillery against uncovered lines. Even traverses afford but an imperfect protection against it. The shot ruin their interior angles, and the explosions of the shells in them act as so many mines of destruction; and as they are directed in enfilade, there are few of either but what take effect.

Ricochet practice, however, is one of perhaps the greatest nicety in the Service of Artillery, and cannot be too much practised: it is the more difficult to regulate with precision, as the actual course of the shot or shell in striking the object can scarcely be perceived, and requires a combination of accurate direction, elevation, and charge of powder, that can only be worked efficiently by well-exercised Gunners.

3. *Direct fire of Artillery to ruin the Parapets.*

By the end of a siege, the parapets on the confined portion of the front subject to the last efforts will be quite ruined by the direct and enfilading fire of shot and shells. For this direct fire, the nearer the batteries are to the place the better.

When direct fire alone is employed against the guns and defences of the fortress, they will never be entirely reduced, except in small confined positions, such as a single flank, and by a powerful and constant fire on it from a very short distance.

4. *Musketry.*

Where severe and well-directed musketry fire can be brought to bear on the embrasures of a fortress, from distances not exceeding from 200 to 300 yards, the fire of the guns has been frequently greatly kept under, and even silenced.

In some of the sieges by the French in Spain, the fortresses being of old construction, without salient outworks, Riflemen, Light Troops, or men of the Line acting as such, were frequently dispersed at some distance in front of the parallels, in small pits dug by themselves, and by their fire kept down the artillery of the place sufficiently to enable the approaches to be carried very close, without employing artillery (of which there was a great deficiency) against the defences.

This is a subject of boast, and a fair one, of the French Engineers.

Although musketry fire has been frequently very effective, and may be so again, it can hardly be relied on with any certainty, as it would appear that many expedients might be used to screen the Gunners from its effect, while the guns are at the same time actively served. If they had even a sheet of linen before the embrasures, so as to conceal the guns from view, there must be an enormous expenditure of ammunition to keep them constantly from being served. (*See* 'Battery,' Plate II. fig. 6, where a hanging mantlet to an embrasure is given.) The troops employed for firing parties in the trenches are usually protected from the musketry of the garrison by sand-bag loopholes along the parapets.

There is usually a very great expenditure of musket ammunition at a siege; in some cases there may be ready means for the supply, but in others there may not, and at all events, *waste*, which it frequently amounts to, is improper.

When parties are required to keep down the fire of the place, it should not be by posting them in large numbers indiscriminately in any situation, to fire at random; but by an adequate number of steady selected men, if possible good shots, placed in the most advanced and favourable points, covered by loopholes of sand-bags, fascines, &c., and never firing but with a precise object and steady aim: after loading they frequently leave the musket pointed, and watch for the next favourable opportunity to fire.

A small quantity of ammunition employed in this way will have a great effect, cause many losses to the enemy, and very much reduce his fire.

5. *Pierriers or Stone Mortars and Coehorns, &c.*

Pierriers are noticed in all works on Attack as an accessory; but there may be some doubt as to any effect being produced from them commensurate with the means required for their carriage, their service, and the narrow limits in which they can be placed; nor will the proper materials for supplying them be easy to procure in many localities.

Small mortars, such as the $5\frac{1}{2}$ and $4\frac{2}{5}$ inches,* are certainly very useful, particularly if employed in considerable numbers; they are very easy of carriage, easy to supply, and can be placed anywhere: their shells, poured into confined spaces, such as the outworks of fortresses, must be very powerful in preventing any strong occupation or demonstration from the works.

As above remarked, everything that is to lead to a rapid and successful progress of a siege will depend upon the adequacy of the means employed for reducing the defences, and the energy and skill with which they shall be used.

Where they are well and efficiently applied, it is easy to conceive the state of the works comprehended within the front of Attack, ploughed up incessantly and in every direction by shot and shell,—not a place from whence a view can scarcely be taken from the parapet with impunity, the moral effect on the troops must be depressing, on proceeding to do duty in such a scene, from the comparative quiet and security of the rest of the garrison; considering that it is not to a fair equal combat, which never fails to arouse the energies of the soldier, but to witness a gradual and discouraging diminution of their resources and hopes.

Even among the Officers and Commanders it will require men of peculiar energy to use very active exertions to see that every possible means of prolonging the defence

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* In the article 'Artillery,' Major-General Lewis suggests the introduction of $6\frac{1}{5}$ brass mortars, (now that the 32-pounder howitzer is established,) as superior to the $5\frac{1}{2}$ and $4\frac{2}{5}$ mortar, though still of a size to be conveniently portable.

be employed in every part. Any weakness or neglect on the part of the Officer in command of even a small outwork may be very injurious to the defence.

THIRD PARALLEL.

After the Second Parallel, that is, within 300 yards, if exposed to a heavy fire, including grape and musketry from the garrison, the progress of the trenches can no longer be *forced* by extensive simultaneous breaking of ground; it is then regulated according to the degree of opposition made: whenever the garrison is inactive, immediate advantage is taken of it, particularly by night, to lay out more or less extended lines of gabions, and to set workmen to fill them at every opportunity: in this manner, especially at from 100 to 300 yards, the work is much accelerated.

While the fire of the place is animated, the operation can only proceed by the full Sap, but from as many heads as possible; when very near, say 50 or 60 yards of the covert-way, it is probable that the only resource will be by the full Sap, during the day; but at night, even then, there will probably be many opportunities of advancing at periods by the flying Sap.

A Third Parallel is usually constructed at about the foot of the glacis, the nearer the better; and subsequently, Demi-parallels for intermediate supports, and cavaliers de tranchée, to gain a *commanding* fire into the covert-way; and even a Fourth Parallel,—all according to the power that the besieged are enabled to put forth in their defence, which however must be very obstinate, and the artillery means of the besiegers inefficient, to render the two last resources necessary; particularly the cavaliers de tranchée, which are very troublesome to construct.

The nature and position of these several works will be best seen on the accompanying diagrams. Plate II. figs. 1, 2.

When the approaches are on the glacis, the enfilading batteries become very much masked, entirely so as regards their effect on the covert-way; and unless the artillery be very ably served, even on the faces and flanks of the works within the ditch.

At this time pierriers, howitzers, and the small mortars are established in the advanced works * to act as substitutes.

The effect of this change of system, however, generally favours for a time the besieged in making renewed efforts to oppose the progress of the Attack.

Portions of the Third Parallel are prepared with steps to enable the troops to march out in order, when required, either for attacking any work, or to oppose sorties. Plate II. figs. 1, 3.

Formerly, the crowning of the crest of the glacis was generally forced under a heavy fire from the garrison, and at a great loss, and was then the most delicate and uncertain operation of the siege; but this has been since superseded by the more effective employment of artillery, which enables it to be gained by the Sap, and without even much delay; the mass of shot and shells dropped into the covert-way during the progress of the siege effectually ruining the interior palisading or other slight intrenchment, which may alone enable the garrison to occupy the covert-way in force, and to attempt to hold it obstinately.

The garrison being driven from the covert-way, the breaching batteries against the faces of the works, and counter-batteries to destroy the parapets of the flanks, are constructed along the crest of the glacis.

In some cases, where the escarps cannot be seen from that position low enough for

* Retrenchments of slight walls, or of palisades, might have light guns brought against them, or perhaps even heavy rockets, so as to hasten their reduction earlier than could be effected by waiting to put the heavy guns in battery.

breaching, it is necessary to construct the batteries for that purpose in the covert-way, an operation attended with more difficulty, and leading to the artillery being in a more confined position, and more exposed to suffer from shells.

During the time of constructing and obtaining effect from these batteries, the passages down to and across the ditch are made.

The communications to the ditch may be made either by blowing down the counterscarp wall and forming ramps down,—or by galleries from the glacis down to the level of the ditch, made on the system explained under the head of 'Mines;' or if there are sufficient means and time, both might be adopted,—the galleries for ordinary service of the Sappers and progressive work, and the open ramps for storming parties.

Where it is necessary to make lodgements and batteries on the breaches of outworks, the passage across the ditch and up the breach is carried on by Sap, full or flying, according to circumstances.

Though the besiegers are, in these latter operations, advancing in confined spaces, and with narrow fronts and little cover, still their position is so commanding from the crest of the glacis, the covert-way, and the outworks,—as in succession they become possessed of them, and the garrison of each work attacked consecutively,—so confined for space, and either so weak in numbers, or if otherwise, so exposed to the vertical fire, while timely support is so difficult to be given them, that the result is usually a question merely of time.

The passages across wet ditches must be made by filling them up for the necessary width and height, the rubbish from the breaches and from the communications down to the ditch tending towards them: the rest is either of fascines or earth.

Where there are running streams through a ditch, it will be necessary to leave sufficient openings for the current by a connecting trestle-bridge; or perhaps side channels may be possible, to afford another course for the stream.*

According to the ordinary modern system of Attack, it is seldom that any Assaults are made than the final one for taking the place, but the breaches are successively occupied, and lodgements made on them by the Sap.

The exceptions are, where a work being once taken is irrecoverable, such as enclosed detached redoubts, or outworks, which can be assaulted while their communication with the garrison is cut off or rendered too difficult to be re-occupied.

In the first case, the redoubt is, as regards the effects of an Assault, reduced to its own isolated means; in the second, the possession of the work will be in the hands of that one of the contending parties which has the easiest communication to it: thus an outwork that is under the fire of the place, and not breached, cannot be held by the besieger; nor can one that is breached, and without an intrenchment perfectly closed against a coup de main, be held by the garrison.

An intrenchment connected with the parapet of a work is no security against an assault, as it will be turned by the parapet, and its garrison driven out with loss.

It does not follow, that because an outwork is taken by assault, that it will continue to be occupied under the fire of the place; the object will be to drive the garrison in from the immediate propinquity, while the communication to the work, and lodgement on it, shall be made secure.

The final Storming of the Fortress takes place when the breaches are practicable, and there are no obstacles left that can, in the judgment of the besieger, prevent his masses of troops penetrating completely into the place.

The assembling situations for the storming parties and supports are arranged, and

* Colonel Blanchard's Infantry Pontoons must now be the resource for crossing wet ditches. —*Editors.*

the communications from them to the breaches, or points of attack, made ample and good.

As great a fire of artillery as possible, particularly from mortars, is concentrated on the breach and interior of the work, immediately preceding the assault and as much as practicable during its continuance, to derange the means of defence, not only the bodies of troops of the garrison, but with the chance of obtaining the premature explosion of live shells, powder-bags, &c., prepared for defence, as occurred at St. Sebastian.

After the works are gained, and the town, or interior of the Fortress opened, the storming party and supports are re-formed, and directed in the manner best calculated for securing the garrison, or driving them into any citadel or interior hold, till when the operation must be deemed incomplete.

This is particularly necessary for Night Attacks, and more especially for the Assault of a Fortress by a coup de main.

In the latter case, if the garrison can rally and repel the assailants, the entire object is defeated, as occurred at the storming of Bergen-op-Zoom, by the British forces, in 1813.

At all Assaults, the main body is always accompanied by at least one Officer of Engineers, not merely to assist in stimulating the party to actions of vigour, although they usually do not fail in that respect, but to afford the advice to the Officers in command which he is enabled to give from his superior knowledge of the nature of fortification, the combination of the several works, and generally of the resources of attack and defence.*

It is usual in Assaults for the advance, (or forlorn hope,) conducted by the Engineer, to precede the main body by, perhaps, 20 paces. The support follows the main body at, may be, 100 paces.

This Article has been written entirely with reference to the principles of Attack of Fortified Places, as they existed up to the termination of the last great continental wars.

Since then, new and improved systems of fortification have been adopted to remedy the ascertained defects of the old ones; and several have been, or are now, in course of construction, which will hereafter require an alteration in Siege operations suited to the changes in their trace.

These new principles of fortification have not been sufficiently classified or analyzed, to enable any decided view to be taken of the manner in which it will be expedient to attack them.

Where they are small, it is probable that in removing some defects the constructors will have fallen into others, of which the besiegers will be able to take advantage.

Where the fortresses are large, (which is the more common case,) the very size, when properly garrisoned, rendered in former days the siege of them at any time so difficult, that it may be reasonably supposed that the exhausting of all the resources of the Engineer's art, and the expenditure of very large sums of money upon them, will have rendered them almost impregnable.

At all events these new fortresses are not common, and for one that will have to be besieged, there will be twenty on the old systems, and for which the present principles of Attack will have to be applied.

J. F. B.

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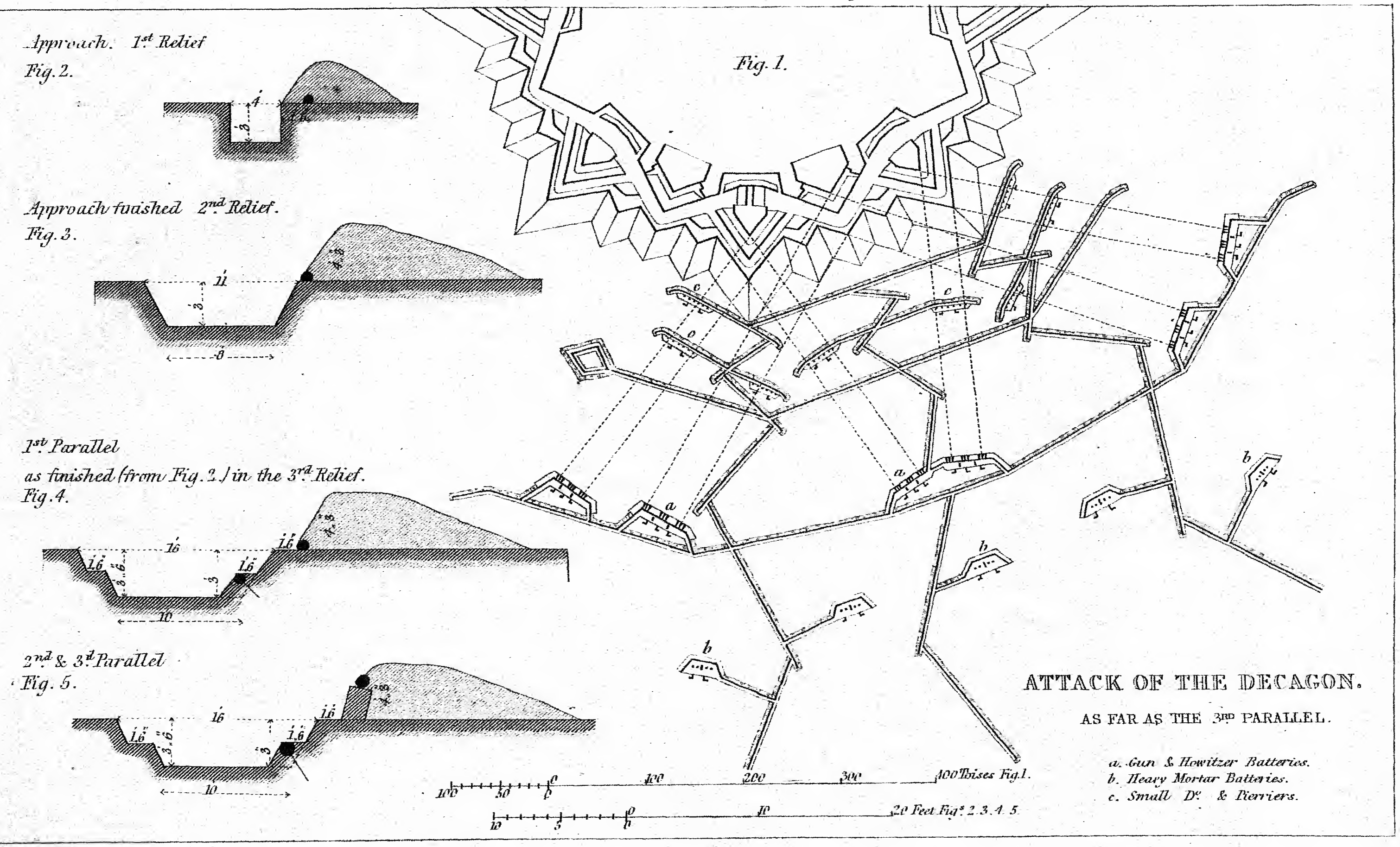
* See 'Assault,' page 116.—*Editors.*



ATTACK OF THE DECAGON.

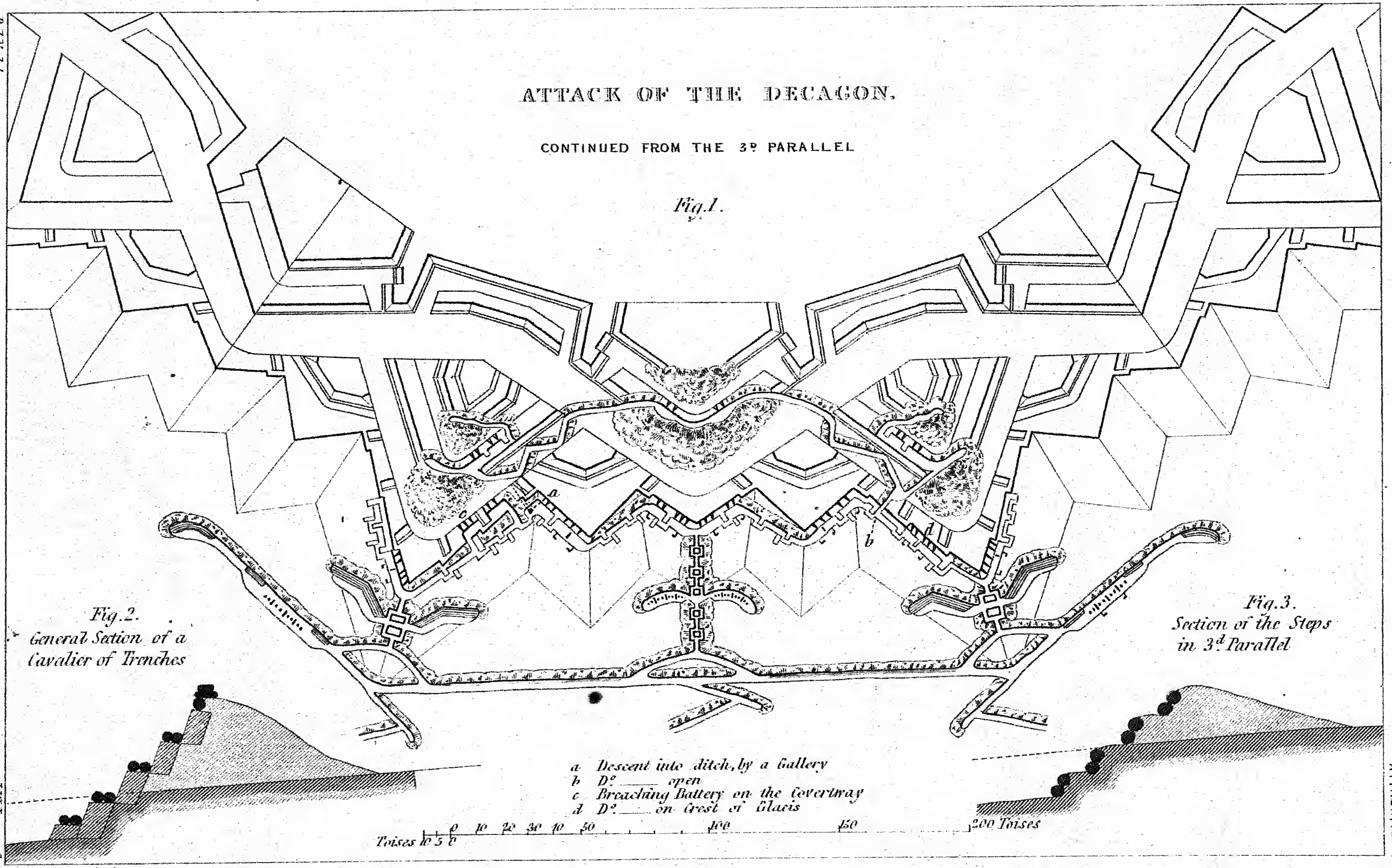
AS FAR AS THE 3RD PARALLEL.

a. Gun & Howitzer Batteries.
b. Heavy Mortar Batteries.
c. Small Do. & Pierriers.

R. J. N. del.

J. W. Lowry sculp.

John Weale, 59, High Holborn, 1845.



R. J. N. del.

J. W. Lowry fc.

John Weale, 59, High Holborn, 1845.

ATTACK OF POSTS.*

Temporary works may be attacked by SURPRISE or by OPEN FORCE; but it will be necessary to obtain accurate information on several essential points before a decision can be made as to which mode will be the most judicious or practicable under the circumstances. For instance, previously to making any dispositions for an Attack, either of a village, an intrenchment, or a smaller military post, a Commander should have some knowledge of the locale, the nature of the defences, and the strength of the force occupying them. It should be ascertained whether they are left to fight their own battle, or are in a situation to receive support, and from whence that support is to come,—how the duty is done,—what is the nature of the ground around it,—whether favourable for concealment or otherwise,—which are the shortest and best roads to it, &c., &c.†

If an intrenched village is to be attacked, it should be ascertained by what means the streets and roads leading into it have been closed,—whether by stockades or breast-works,—how these obstacles are flanked,—whether from neighbouring houses or temporary works thrown up for the purpose,—what obstructions are placed in front of them, whether abattis, or trous de loup,—how the houses forming points in the main enclosure have been strengthened,—whether there is a keep, and of what nature it is,—and how fortified,—whether there is any building occupied on the outside as an advanced post,—where the pickets are placed, &c.

If the Post is an isolated building, such as a country house or church, attention should be directed to the mode in which the doors have been barricaded, or the windows blocked up,—how the loopholes are arranged,—what sort of flank defence has been obtained,—how it can best be approached,—what internal preparations have been made for prolonging the defence, &c. Part of this 'useful knowledge' may be drawn from spies, deserters, and maps, not however trusting any of them much further than they can be seen or verified; and for the rest, there is nothing comparable to seeing for one's self, and therefore even an open reconnoissance, or a secret peep, must somehow or other be obtained.

These hints will suffice to shew that there are a multiplicity of objects which require to be looked to, before an opinion can be formed as to the best course to pursue; and unless some previous information is obtained upon some or all of them, false calculations will necessarily be made, unexpected obstacles will be encountered, and hazardous enterprises will be undertaken, all which might at least have been modified. With superior numbers in hand, and no very great show of opposition in front, it may be difficult to exercise patience, and just to find out what one has to encounter both before and behind the little level lines of parapets and palings. There may be some great yawning ditch, either 'to you,' or 'from you,' which it is not so easy to take 'in your stride.' And things are not always quite so smooth as they look; it is therefore better to find out if you can, and prepare accordingly.

The dispositions for the Attack, of whatever nature it may be, though they require to be made with great circumspection, and executed with the utmost celerity, decision, and effect, do not perhaps call for so many precautions as are necessary for the defence of a work. It is with the assailants to choose what they will do,—with the defenders,—on very short notice, to conform and make the best of it. The first object of an Attack is to get—*at* the people who are defending a work, and then—*to beat them.* To secure the former, a Commander would naturally seek for a point which presented the fewest obstacles, and when he saw where to strike the blow, he

* By Lieut.-Colonel Jebb, C.B. & R. E.

† See Plates to article 'Defence of Posts,' in this volume.

would accomplish the latter, by hitting 'uncommon hard,' so hard as to make his adversary reel under it, if it did not knock him head over heels, and get rid of him altogether. These main objects being kept in view, everything that would conduce to secure them must be studied and carried into effect. He would therefore arrange his plan with the utmost caution, and execute it with corresponding vigour. It will be obvious, that where it is practicable, several real Attacks, or one *leviathan* and several false ones, will distract an enemy's attention,—divide his forces,—tend to disturb him and shake his confidence,—render his combinations more perplexing, and, in short, give him more to attend to, with diminished means of doing it, than if one Attack only were made. It is usual, therefore, where circumstances permit, to attack several points at the same moment, or in quick succession. To effect this, the columns are formed under the nearest cover that can be found, from which they advance with as much celerity as will leave the men *fresh* when they get to work. To regulate even this properly is a point of no small importance;—for instance, if a column has any considerable distance to move, in the face of a smart peppering fire, and they start at too great a pace, they may be brought to a stand-still before they can close with their opponents, and that too when the fire upon them, from its diminished distance, is the more deadly. The means of moving *powerfully and swiftly at the last* must be preserved at all events. This forward movement is covered by Light Infantry, who would halt on the outside of the ditch or other obstacle, and whilst the column was engaged in getting over it, would endeavour, by good steady shooting, to aid the operation in keeping down the enemy's fire, or putting down any overt acts of opposition on the part of the defenders. It would be a weak proceeding to permit any of the men *in the column* to amuse themselves by firing; and, to prevent disappointment, it might be explained that they have much more serious business to attend to with the bayonet, and till that is done, they should think of nothing else. Any little *decided leisure* might be so employed by a few of the leading files being disposed in front for that purpose, whilst the others were lying down to cover themselves; but the main point should never be lost sight of, no time should be wasted upon it, for the assailants and defenders, under such circumstances, are far from being on equal terms; the former being exposed from top to toe all in the open, and the latter at the worst would be covered up to their chins.

Each column designed for making an Attack is usually divided into two parts, the relative strength of which must be determined by the nature of the operation,—the number of the defenders,—and a train of probabilities too long to be enumerated here. One party is for storming the work, and the other is placed in reserve to be applied as events turn out, either to assist in following up and taking advantage of success, or as 'a friend in need' to fall back upon, in case of disaster. The former of these parties may be again subdivided into two or more parts, one for the first onset and the others for support; but this should be more *nominal* than *real*. The question is, shall we send the whole storming party on, in one mass, or shall we first *start* it in separate detachments, and then let it *finish* as one mass? We require the moral as well as the physical effect which NUMBERS will produce, in order to penetrate the enemy's line, but if we can secure those essentials when wanted, it does not appear necessary to expose the support or the *tail* of the column, whilst any work is going on which the *head* of it, or the real storming party, can effect just as well by itself. For instance, there would be little good gained by a vast body of men being halted under a close fire, whilst workmen were engaged in cutting a road for them through palisades or an abattis, or whilst the leading files were rearing ladders for an escalade, &c. The *moral effect* and confidence produced by *numbers*, which it is most essential

to study, would be still retained if the *head* of a column could feel assured that it travelled with its *tail* on, though it could not see it, and that however fast the one might move, the other would be certain to follow: and the *physical effect* or *force* that is required for an onset would be equally secured by the same means. Numbers are in either case the chief ingredient; the only thing to be considered is the proper application of them. This is confessedly rather a nice point to manage, and such as it is more easy to theorize upon than to carry into effect; but if troops are handy, and are accustomed to work together, and to be *sure* of each other 'in sight and out of sight,' and their efforts are directed by the hand of a master, there do not appear to be any impossibilities attending its adjustment; at any rate the principle, if true, is not falsified because the practice is difficult. In Night Attacks, for example, it is especially necessary that all the arrangements should be the simplest possible,—and under such circumstances an undivided force would be preferable to risking a mistake being made in the administration of separate parts of it.

In carrying out the principle of the storming party and its support marching separately, we ought to find that as the leading files of the former became engaged, or as the explosion took place which was to blow the barrier to atoms, by which they were to enter a work, the supporting column should be close at their heels,—to add their weight to the first shock,—to inspire confidence,—join in the cheers,—and be at hand to rectify anything that might happen to go wrong. These little *delicacies* cannot be brought within the precise limits of any rule which shall be of general application, whether as respects distance,—or time,—or pace,—or anything else. It is the Commander who has the right kind of head on his shoulders, and an eye that is good for something in it,—who can alone apply the principles, and regulate them on the spot.

Troops aided by musketry in the manner adverted to, would plant ladders for escalading,—Sappers would cut away palisades,—blow open barriers or gates,—make steps in slopes that were too steep to be ascended, or clear away impediments, and a steady charge would then take place. Not one man running at the top of his speed and another after him,—that is not the way to get rid of a set of resolute fellows. It must be a steady charge, or rather a quiet determined rush; the whole weight of the column is wanted to make the desired impression on the adversary's line; and if it is frittered away bit by bit, much of the effect is expended in individual acts of heroism, which might be more usefully employed. Where several attacks are made, the columns may as well all march on the same front, in subdivisions, or a greater or less formation as might be convenient, as it will make it more difficult for an enemy to estimate numbers, or distinguish the real from the false attacks; and the latter should look and act as if they intended mischief, however innocent their designs may be. They should also be of such a strength as to command respect, in order that they may be in a condition to profit by unforeseen success: the *number* of attacks should therefore be in proportion to the force that is to be divided. How frequently has it happened, that a false attack which would have been considered as too rash and hazardous an enterprise to be thought of seriously for a moment, has been crowned with a success which has equally astonished friends and foes, whilst others which have been judiciously planned and organized have altogether failed!

It is explained further on, that the 'top o' the morning' is not a bad time for making an Assault; this is chiefly because the previous movements are concealed by the darkness, and the loss is diminished in proportion. For instance, under favourable circumstances, it would be quite possible, after driving in an enemy's pickets the preceding evening, secretly to dispose a firing party close to the ditch on the outside

of a work, without a hostile shot being fired, (for they are not always prepared for illuminating the exterior by light-balls,) and to have a column at no great distance waiting for the precise moment most favourable for the Attack; and when the troops did advance for an escalade, or whatever the operation might be,—what would happen? The alarm would be given, and the parapets would be manned; but opposed by a firing party, drawn up perhaps three deep within a distance, it might be of 20 or 30 yards,—who could shew himself to give his fire? Let us see the man that would be long 'in easy circumstances' with his head and shoulders above the parapet! If sand-bags had been disposed for protecting the defenders, a few shots might be fired through the loopholes, but their effect would be as nothing. Only those directly opposite a column could be brought to bear at all at that distance, and with good arrangement there would be no time for mischief to ensue, even if there were more opportunity.

Circumstances, however, will arise when an undisguised Attack in broad daylight may be imposed. There is of course more previous *exposure*, but people *see what they have to do*, and can therefore act with more decisive effect. In the preparatory movements, and during the advance of the columns, violence must in this mode of attack control opposition, instead of its effects being eluded by secrecy or concealment. The employment of Light Troops and Artillery are the chief means which may be applied by the assailants for effecting this object; the former can act as a firing party under any circumstances in covering the advance, but it is quite necessary there should be light enough, in order to derive all the benefits which the latter can bestow. Artillery can effect that from a distance, which without it Infantry would have to execute for themselves, under all the disadvantages of a close fire. Thus by firing in a slanting direction at stockade-work,—an abattis,—or palisading,—these obstacles become so damaged and torn up, that a passage improved by the use of the axe is readily effected through them. Barriers may be knocked away from doors or windows,—walls may be breached, or the defenders in a building may be very much incommoded by its effects; for shot will go through and through ordinary houses, and if a lively fire is kept up, they soon cease to be comfortable quarters. By firing shells into parapets, that portion which covers the defenders may, if time admits, be partially got rid of, and when all these good things are effected from the front, the guns being moved to one of the flanks, so as to obtain a general enfilade, may keep up a fire till the moment of Assault, which will unsettle the defenders and insure a corresponding advantage to the Attack: in fact, it is difficult to say what a brigade of Horse Artillery or a battery of 9-pounders *cannot do* against a military post fortified in haste, or indeed against anything else.

The principles on which Attacks are conducted, and the general arrangements for executing them, will be gleaned from Jones's 'Sieges,' in the example of two assaults on Fort Christoval.

SURMOUNTING OBSTACLES.

In the Attack of Military Posts, especially such as are of minor importance, Infantry are more frequently than otherwise thrown entirely upon their own resources, for forcing a passage through whatever obstructions they may fall in with, before they close with their adversaries. They have then no guns or howitzers for tearing up and destroying stockades, abattis, palisading, chevaux-de-frize, &c., and have only to trust to their own exertions for getting to the *right side* of them. The nature of the obstructions which are usually employed for adding strength to fortified Posts is detailed in the article 'Defence,' and the means to be adopted for surmounting them will now be briefly adverted to.

HOW TO DEAL WITH AN ABATTIS.

An Abattis is probably the first obstacle a column will fall in with, and an awkward obstruction it is, if it has been properly managed, and the materials have been of sufficient size and weight. In an Attack by surprise, an endeavour should be made to get round the flank of it, and if that 'wo'n't do,' the men must try and crawl through it in the best manner they can, avoiding any noise, and forming again as they succeed.

If the Attack is by open force, and the abattis should prove impenetrable, there is no harm in making the attempt to set it on fire. A few resolute fellows, carrying small fagots which have been previously dipped in pitch, and each man provided with a 'lighted portfire,' if it is day-time,—or if they can approach unseen by night, with some other means of setting fire to them,—must rush up from some neighbouring place of concealment, covered by a smart fire of musketry, and throwing in their lighted fagots, all will soon be in a blaze. When that has subsided, and there is no fear of the men's pouches being exploded, the breach will be practicable, without waiting for the hot cinders to cool. This little conflagration would go on under the protection of a party, near enough to prevent any attempt on the part of the defenders to extinguish it. If, however, an abattis is formed of small materials, or if sufficient precautions have not been taken to secure it in its place, (that is, if it is *a bad one*,) it will be a waste of time to submit to the delay of burning it: in such a case, a party rushing up with ropes may tie them to some principal trees; or a big hook fixed to a rope or pole may be used, and a tree or two may by these means be dragged forcibly out of the line; or some handy fellows with good tools may partially open it, by cutting away a few of the small branches, so as to let men get through at 'open order.'

HOW TO OVERCOME OTHER IMPEDIMENTS.

If the obstructions outside a Post consist of military pits, stakes, or the stumps of trees, &c., they may be passed at 'open order,' if they cannot be avoided, and the columns be re-formed as soon as possible. Small ditches may be filled up with fagots or bundles of hay,—chevaux-de-frize may be displaced by main force, with a rope and a good pull altogether,—or they may be cut up or blown to pieces with a bag of powder; palisades, or fraises in a ditch, may be got rid of in a similar manner,—or if a party is provided with ladders or planks, and the ditches are narrow, these last obstructions will frequently offer facilities for constructing temporary bridges for passing over them. Stockade-work or palisading may be escaladed with ladders brought up in a line under the protection of a firing party, and carried by two or four men, according to their length. The ladders should be planted as close together as they conveniently can be, and the assailants should mount them on as extended a front as their numbers permitted; or a stockade may be breached by the explosion of a bag of powder, &c. By some such means as these, applied with boldness and decision in a common-sense sort of way, troops, assisted by workmen, would be a match for any of the ordinary obstructions which might oppose their advance, whether the attack were made by night or by day, by surprise or by open force.

OF ATTACKS BY SURPRISE.

A Post is said to be *surprised* when an enemy either gets into it, or close up to it, —by making a false or forced march, information of which has been concealed from the defenders, either by their own bad look-out, or their opponents having been favoured by fog or darkness, &c.; or it may be that they have succeeded in quietly cutting off some advanced Post, which would have given the alarm.

When ably planned and carried into execution, a surprise is the best kind of Attack

that can be made; there is less *exposure* beforehand, and from being unexpected, there is, from the nature of things, more confusion among the defenders, and therefore less *resistance* afterwards. The result also is generally more decisive, and smaller numbers can act with far greater effect against a superior force than can be hoped for in an open Attack. It is only, however, when an adversary fails in his precautionary measures that success can be confidently anticipated, even from the best formed schemes of surprise; and even then, without precise information as to the nature of the defences,—the strength of the defenders, and their measures of security,—without ascertaining the *degree* of caution and punctuality with which the duties are performed,—any attempt at a surprise would most probably fail.

Neglect in the *external* precautions of security, such as a faulty disposition of the outlying pickets and videttes,—the omission of patrolling, &c., *admits* of a surprise; and an absence of judicious *internal* arrangements will *facilitate* it. The first will consist in placing but few pickets, and those at too great a distance from each other, and too far to the front, so that the chain becomes unconnected, and the communication between them is not properly preserved; or in falling into an opposite error, of placing them so near to a Post as that they do not secure sufficient notice of the presence of a hostile force, to enable the defenders to stand to their arms; or it may be traced to a slovenly manner of carrying on the outpost duty generally. The second will depend upon the degree of discipline and readiness prevailing among the troops generally, and the dispositions that may have been made for applying their services in the most effective manner, and in the shortest possible time, &c. The following are likewise circumstances that will favour this mode of proceeding.

When there is a wood or ravine within a moderate distance of a Post,—when you have the power of secretly assembling a force equal to the undertaking, which was before dispersed with a different object,—when the defenders think themselves in security, either from your distance or other causes, and are therefore less on their guard, and less vigilant,—if the Post is not quite complete in the works designed for its defence,—if the troops are raw, and their chief not much better,—or if from being deemed inaccessible, when that fact is fabulous, any part is not so well guarded as others,—these are all very tempting circumstances to try one's luck at a surprise.

Secrecy is the soul of a surprise, and as a secret is liable to 'fructify' when in the hands of many, the less that is said about any intention of beating up a neighbour's quarters the better. Your enemies must, of course, be deceived, or kept in ignorance, and until the moment when their exertions are required, it would be quite as well for your friends to be so too. The requisite preparations therefore in collecting ladders, tools, &c. should be shielded under cover of being for some other distinct operation, and plausible excuses given forth to allay suspicions as they arise.

Among other considerations, it will have to be decided beforehand whether the Post is to be held and defended, should it be taken, or whether it is to be destroyed or abandoned. In the former case, a temporary supply of provisions and ammunition should be thought of; in the latter, the attack and retreat only have to be provided for.

Winter is the most favourable time of the year for attempting a surprise. Sentries are not usually so much on the alert in cold weather, and the long nights and the storms and fogs, which prevail at that season, are all 'accessories before the fact.' A night when the moon sets just before you want to begin the Attack is advantageous, as the previous movements will have all the benefit of the light, and the succeeding darkness may serve an equally good purpose.

It is generally admitted, that the peep of day is, under most circumstances, very favourable for making an open Attack, when there is not light enough to betray the

advance, or any of the preparatory movements, and the assailants have the advantage of daylight immediately after to profit by success, in securing all the advantages they may have gained. But an enemy knows this as well as anybody else, and the whole disposable force of an army or garrison is generally under arms at that time, and probably more on the look-out than at any other hour of the twenty-four. This, therefore, is not the best time to catch them unprepared, and it would appear, that getting up a little earlier, or sitting up a little later than one's adversary, would afford a better opportunity. As to time, therefore, soon after midnight would probably be the hour; and if it could be made to square with the object in view, which may vary with circumstances, it would probably be as favourable a time for the attempt as any other: for example, if the Post were at no great distance, and the intention was to destroy and then abandon it, before succour could arrive, a better hour than midnight could not be selected, as it would afford the opportunity of accomplishing the object, and making good the retreat before daylight. But if the Post were to be held afterwards, the dawn of day immediately after the assault would enable a party to make better arrangements for defending itself, and a later attack would therefore be preferable.

From these considerations it will appear that a surprise, whether early or late, generally entails a Night Attack, and it is scarcely necessary to say that the greatest precautions, and the very best arrangements, are required for carrying it into effect; nor can success be reasonably looked for without them. The worst of going to work in the dark is, that unless the point to be attacked is of a nature not to be mistaken, it is ten to one the attempt to identify what is doubtful will disclose all. Nothing can be worse than having to poke about, especially if you don't want to be found out, which is rather an essential in a surprise. Again, when you have forced an entrance, we will say into a village, unless you are perfectly acquainted with the interior, and familiar with every object that presents itself, there are other and great disadvantages to contend against. The local knowledge of the defenders is all in their favour,—the offensive cannot be continued with vigour, and nothing is gained in furtherance of your object by standing still. Dangers are magnified in the dark, especially when men are not excited; and as a resolute enemy will know exactly where to strike the blow, and you can neither see from whence it comes, nor estimate its force, till you feel its effect, it may become necessary to assume a defensive attitude; and this, under the circumstances, may lead to a reversal of your previous success. If there is work to do with the shovel and pickaxe, such as effecting a lodgement for establishing yourself on the ground that has been gained, or for other purposes, the darkness is favourable for the execution of it; but this does not affect the present question. Under any circumstances, however, the value of the local knowledge, which is conspicuous among the useful items adverted to, will be apparent, and with other hints which have been thrown out, will serve to create a suspicion that there is something for a Commander to think of, before he makes up his mind to commit himself in action.*

The number of men for an Attack ought, under most circumstances, to be superior to the force of the defenders, which it must not be forgotten have the 'vantage ground; but in a well conceived and vigorously executed surprise, very inferior numbers, profiting by the confusion and astonishment which are inseparable from an unexpected Attack, have done '*impossible things*,' and doubtless can do so again; which it is as well to remember when any similar opportunity should happen on service: generally,

* Surprises in the open day can seldom be successfully undertaken, except in mountainous countries intersected by ravines and hollow roads, &c.

however, numbers are one principal ingredient in success, and therefore the means for the Attack should be adequate to the object, taken in all its bearings. A very inferior force may possibly make good their footing against all opposition at any certain point; but the question may be, can they maintain it?

This question arises with a greater or less demand for an answer in the affirmative, according to circumstances. For example, a modest Commander may prescribe limits to his ambition, and merely wish to set fire to a Post,—a village,—or dockyard, or to blow up a magazine, or some other equally inviting object, and then peaceably to retire, without any desire further to trespass on the time or attention of his opponents. A few minutes' possession of a certain spot might suffice for the accomplishment of any of these purposes, and it might be that a very few men would be sufficient to force an entrance and effect them. In a well concerted surprise, a small force might possibly be brought almost within arms' length of the desired object without discovery, and when a rush was made for securing it, there might be all the routine of sounding the 'alarm and assembly,'—of turning out guards,—and probably some marching and counter-marching to perform, before the nature of the Attack, or even the point or points where it was made, were clearly comprehended by any large body of the defenders; and before they had rubbed their eyes, and made their dispositions for repelling it, the deed might be done, and the actors be on their way home again.

If however the Post which is attacked is to be held afterwards, '*c'est une autre chose;*' defenders have an unpleasant way of sometimes recovering from a first panic, and then the preponderance of force should be on the right side, or 'the tables may be turned.' There have been instances, however, quite within the memory of the present generation, of a very inferior force surrounding a respectable work strongly garrisoned—carrying it by assault in the night, and making the defenders lay down their arms before daylight told any tales as to the disparity of numbers.

The success of such enterprises as these, which have for their object to effect what greater numbers ought to be employed about, depends entirely on the advantages resulting to them from a complete surprise, and coming upon an enemy when he is quite unprepared: in fact, if this is not done, the attempt ought to be abandoned at once.

The execution of an Attack of this nature is rather a *delicate* affair, for if by any means the suspicions of a vigilant adversary have been awakened, he will have made such dispositions as might cause the surprise to be felt on the *wrong* side. If, therefore, there should be the least cause for suspecting that an enemy is playing tricks, every possible precaution should be taken for ascertaining the truth, before getting into a difficulty which it might not be easy to get out of. The main body should be halted at a greater distance than it is likely an ambuscade would be sent, and the whole ground in the front should be '*felt*' with the utmost caution by patrols, who, if not stopped by outlying pickets or videttes, &c., should creep close up to the place, listening to everything that is going on. If on their report it should be decided to move on, it would still be prudent to do so with all circumspection, having an advanced guard composed of men who know what they are about, and parties with the same view to protection on either flank. If, on the contrary, there were good reason to believe that the enterprise was no secret, and that everything was in readiness to give you a warm reception, it would depend upon circumstances whether 'prudence' would not be 'the better part of valour.' These observations of course only apply to a force quite inadequate to any open attempt; but with a proportionate force, should there be a failure in the design of surprising a Post, the probability of which would have been foreseen and provided for, it would only be necessary, under such circumstances, to throw off the mask,—proclaim yourself an open enemy, and

fight it out, which all your previous arrangements would enable you to do without difficulty.

The whole force employed, whatever it may be, should be divided for fulfilling specific objects. Several columns of Attack may have to be formed,—some for false, others for real Attacks, each to be closely followed by its support: there should also be a certain force posted in reserve for covering a retreat, in case of failure; another, probably, for guarding particular points, in order that, should your designs have been anticipated, you may not be surprised in your turn by an attack in flank or rear. Men with axes, sledge-hammers, crow-bars, &c., for forcing barricades, or cutting away obstacles, and a few bags of powder with fuses attached, for bursting open gates, would likewise be useful. The troops employed on these little enterprises should be picked men. Guides, if they can be depended on, will be necessary, in sufficient numbers to allow two or three to accompany each party, but *personal* knowledge in the assailants or their leaders is a better thing, and more conducive to success.

Whatever may be the time or disposition that is decided upon, the march must be so ordered as that the column or columns shall arrive at some point in the immediate neighbourhood, perhaps a mile, or a mile and a half distant, an hour or more before they will be wanted, so that the last orders may be given, and the final arrangements made; for there is generally a parting word to say on these occasions. This arrangement for the march presupposes that all the requisite information respecting the situation of the pickets,—the mode of patrolling,—and the general *external* precautions for guarding a Post, have been obtained, so that a Commander knows what he is about, and can put his different detachments in movement for the several points he intends to attack. But if this information has still to be sought, in consequence of the enemy's pickets being posted differently every night, or other causes, the troops must either be brought up earlier, and wait till these points are determined, or a patrolling party must precede them, so as to get there at dusk, and have it all ready. In the former case, arriving at the halting-place by such roads as afford the best means of concealment, some steady and intelligent men should be detached to patrol to the front; first to ascertain, if possible, the situation of any pickets which might have been posted wide apart, and then to find out the order in which the videttes were placed,—the mode of patrolling between them,—and any further information that could be obtained. The success of the enterprise depends upon the chance of introducing the whole force unperceived within the chain of pickets. The state of the weather will materially facilitate this preliminary step; and when it has been accomplished, the advance should be continued until the columns are discovered by the sentries of the Post, when a general rush would be made, and the more impetuous the Attack, the more favourable for the object, of following up the *surprise* by an easy *conquest*.

DISTRIBUTION OF THE ASSAILANTS, &C.

A multiplicity of considerations will influence the distribution of the assailants, so that it is hopeless to lay down any rule of general application; but we might say on a broad principle, that it would not be prudent to divide a small force too much in attempting false Attacks, and that therefore, from one-half to two-thirds of it might be formed for the assault, keeping the remainder in reserve for covering the retreat, and acting according to circumstances;—or were the force considerable, and the Post to be attacked of corresponding extent, such as an intrenched village, perhaps one-third of the numbers might be formed for the principal Attack, another third be divided for two false Attacks, and the remainder be left in reserve for the purposes before stated. In the former case as a minimum, the assailants should be at least equal in numbers

to the defenders; and in the latter, as the force is more divided, there should be a proportionate increase; that is to say, the numbers engaged in the three Attacks should be stronger than the garrison. A part of the force engaged in the false Attacks, or a portion of the reserve, should be placed not very far from the entrances to the Post that are nearest to the point where the real Attack is going on. These may be streets, roads, or gateways, &c., and they should be watched, that advantage may be taken of their being turned or opened; some workmen, who are 'good at need' for breaking open barricades, being held in readiness to accompany the party.

When all these particulars had been arranged, and the Officers or Non-commissioned Officers commanding the several parties had been made clearly to understand their orders, and the specific objects confided to them;—when the conduct they should observe under every emergency, both during the Attack, and in the event of success or failure, had been explained; when the precise moment on which the Attacks should take place was perfectly understood,—and some conventional signal, countersign, or badge had been established by which men could recognize each other in the dark,—the columns would be in readiness to move on. The advance would be made in silence, and without haste; the columns dividing when they got near the place, and marching by the best route to their points, preceded by a few steady soldiers as an advanced guard, who would be on the look-out to secure any patrols or videttes they might fall in with, so as to prevent their giving the alarm.

OF THE ATTACK.

If the object of a column were to assault a field-work, which has usually a ditch bounded by slopes of earth, the advance of the storming party would silently slide down into the bottom of it, and if there were no obstacles, such as palisades, &c., and the slopes admitted of their scrambling up, they would form in the bottom of the ditch in subdivisions, or sections, as might be ordered, and endeavour to go up together without straggling; the remainder of the party following them as closely as possible; the support being halted at the edge of the ditch, ready to fire or advance, and the reserve being posted further off.

If there were unforeseen obstacles, which could not be got over or removed without the noise of workmen, the secrecy of the operation would be nearly over, and it would be time to awaken the *astonishment* of the garrison. A few preparations being made, such as the storming party lying down opposite the spot, and the support or firing party on either flank ready to keep people off the top of the parapet, the workmen would glide into the ditch, and first distributing themselves judiciously, and finding what was to be done, and the best way of doing it, they would commence work together, and regardless of anything that might happen, would lay about them till they had accomplished their task; when the assault would immediately be given, and the endeavour made to charge in column, through whatever force was formed for the defence of the parapet: when this was accomplished, a halt would be made, to re-form for further operations in following up the advantage gained.

After troops once move forward to the assault, the bayonet should be called upon to do all the work; very little is gained by the leading files firing down upon the defenders from the top of the parapet, especially in the dark or the grey of the morning. It has only a tendency to check their speed at the moment it is of some use to them. The assailants are at that time exposed, and perfectly visible against the sky, when the defenders, however near, could not be seen; and after the first man has jumped down within a work, his comrades must, of necessity, cease firing; therefore anything that would be gained by permitting its use would be more than out-

weighed by the inconveniences that would be entailed. It is usual, therefore, to make use of the bayonet only on these occasions.

If a wall, or any other obstacle of a moderate height, had to be scaled, the ladders would be carried by the advanced party, who would plant them side by side, and after its being ascertained that all were properly in their places, the troops would advance up them in the most compact order, and on as extended a front as possible, and jumping down inside, would form again and move forward, as soon as circumstances permitted. Stockade-work might be scaled in the same way.

BLOWING OPEN BARRIERS, &c.

In the Attack of gateways or houses, if secrecy is preserved till you get close to them, it is as much as can be expected. In order to force the barriers or doors, the most effectual agent is a bag of gunpowder. A bag containing from 20 to 30 or 40 ℔s., according to the expected strength of the obstacle, and furnished with a fuse for firing it, and a loop to hang it by, can be easily nailed or hooked up against a pair of gates, or fastened to a barricaded door. If it can be done without previous discovery, so much the better; and for effecting this, a gimlet will be found a very useful, quiet operator. When fixed, the fuse is lighted, and the man retires a little. The party for forcing an entrance may be drawn up within 15 or 20 yards, and a few expert men with axes and sledge-hammers may be with them. The explosion will most probably do all that is required, and the ruins, if any remain to impede the advance, will quickly be got rid of by the workmen. If all this has been done in secret, it will be a great object to take advantage of the bustle and confusion that will ensue, by making a vigorous Attack. If, however, the secrecy of the operation is at an end before the bag is fixed, and this has to be effected by open violence, in spite of what may be attempted to prevent it, the best proceeding is for a strong firing party to rush up, and throwing themselves under any cover that might offer, to reply to, and endeavour to subdue, the fire that defends the point to be attacked; and when that slackened, the men with the bag of powder should make a run of it,—fix,—light, and 'be off.'—See article 'Petard.'

SECURING POSSESSION OF A POST AFTER A SURPRISE.

In the Attack of a village, or even a smaller Post, the moment an entry is made, a portion of the force should be detached to endeavour to communicate with the other Attacks, if there were any; and leaving a party in reserve at the point where they came in, they should secretly march, if the alarm had not been given, to secure the guards and principal avenues into the village. By thus gaining possession of the barricades or gates, they would be enabled to open a communication by which a portion of the reserve, which should have been previously held in readiness, might enter. If they were discovered, and the garrison were assembling to oppose them, the same measures would be of advantage, and no time should be lost, in also making a furious attack on the main body wherever it might be forming, taking care, during the advance, to secure the means of an orderly retreat. The value of *local knowledge*, indeed its absolute necessity, is again apparent, for how could any of these steps be taken with the promptness befitting the occasion if this were wanting?

OF ATTACKS BY OPEN FORCE.

An Attack by open force is imposed when something like the converse of all the circumstances that would favour an Attack by surprise exists;—such as the ground outside a Post affording no cover for approaching it,—or when a Post is so well and

so vigilantly guarded that it becomes a measure of necessity, from having no choice left between an attack or a retreat, as might happen in a general action;—or an attack of this nature may be undertaken with confidence when the works are weak or unfinished, and where there are facilities for enfilading its principal lines with artillery;—or when a Commander is known to be timid.

Most of the information required for judiciously planning an Attack by surprise will be also of essential service when an Attack by open force is contemplated; in either case it is equally of importance that a knowledge of the locale should be previously obtained, and that the obstacles to be overcome should be carefully estimated, and compared with the means proposed for surmounting them, before troops are committed in the attempt: something must of necessity be left to chance and good fortune, but not too much. If a choice exists as to time, or should it so happen that circumstances permitted a force to evade any previous exposure, by attacking in the night, or before daylight, so much the better; but if the Attack is made in the open day, and there is neither natural nor artificial *cover* to favour the enterprise, the strongest and most energetic measures should be adopted to control or subdue the fire that would be poured in upon an advancing column, which is the worst treatment it has to endure, because it is in no condition for making a reply '*in kind.*' When the leading files get within arms' length of the defenders, an exchange of blows may take place, but not before;—hence the advantage of a 'cloud of light troops,' or of a strong firing party, for the specific purpose of protecting columns engaged in the attack of works, of whatever description they may be.

Though there is a great difference in the two modes of Attack under discussion, because in one it is assumed that an enemy is half asleep, and in the other, that he is on the alert, and that all the means in his power will be developed to oppose it, yet in their *principles they are the same;* and as a notion of these principles and of further details may perhaps have been obtained from the preceding pages in which they are treated of, a repetition of them would be superfluous.

The points requiring attention and the dispositions to be made after a successful Assault have also been glanced at, and equally apply to the more open mode of Attack under consideration. But as an enemy will be better prepared for making resistance, the measures will require to be of a more decided character, and no time should be lost in following up the advantage of a first success. A reserve would be left at the point where the entry was effected, and according to circumstances strong detachments would be sent off to the right and left to follow the enemy and sweep the interior of the defences; leaving guards at every entrance of a street, road, or alley, by which they might be cut off. The gates and principal avenues opening towards the side attacked would be seized, and access given to troops from the reserve, which should be held in readiness to enter, and an impetuous attack would be made on the main body as soon as a sufficient force was assembled. If there were a keep, the Attack should threaten the communication with their stronghold, and if circumstances permitted, a rush should be made to cut off their retreat to it, or to *intrude*, by joining the party and going in with them.—See 'Assault.'

ATTACK OF AN INTRENCHED VILLAGE.

It is sufficient to give a few practical observations upon the mode of attacking the chief works, in which we may suppose the strength of an intrenched village to consist; which will bring us in contact with fortified houses, or churches,—redoubts,—flèches,—or other earthen-works, some or all of which may flourish as independent posts, or form part of the contour taken up for the defence. See Plate of 'Defence of Villages.'

ATTACK OF FLÈCHE, OR EARTHEN-WORK, OPEN IN THE REAR—A REDOUBT, &c.

All detached works, of the nature of a flèche, that are said to be open in the rear, are usually so far closed that they have at least a good palisading and barrier gate to shut them in; *au reste*, they are generally earthen-works, having ditches of a breadth and depth varying with their importance, either revetted or finished in slopes, with a palisade in the bottom. The rear, however, is generally the weak point, and it is left open in order that it may be defended from some other work which sees into it. To assault such a work, if it is of considerable size, several columns of attack may be formed; the principal one, however, should be directed upon the weakest point, and it should be held in reserve, and if possible concealed, until the threatening attitude of the other attacks (which may be directed on the salient or the extremity of either face) shall have induced a corresponding disposition of the defenders; it may then come on in all its glory, and make short work of the palisade by some of the means before described, the other columns acting according to circumstances. If it should so happen that it was not expedient to attack a work of this description by the rear, —the general plan of operations would be reversed, and a show would be made of attacking that point, when in reality the principal effort would be made on the salient angle, or some other part, by a column kept out of sight until the attention of the defenders had been previously engaged.

If the ditch of a flèche or other outwork is bounded by walls, an escalade with ladders becomes necessary, for it is a long business filling up a ditch with bags of hay or anything else, a dangerous one to jump into it when deep, and an impossible one to get out of it when you are there, unless the retaining walls are very insignificant indeed. If the ditch is not revetted, but still the slopes of earth are too steep for men to scramble up, ladders applied to them will answer the purpose admirably, and if ladders are not to be had, rough steps may be made by workmen accompanying the columns; all these operations being under the protection of a strong firing party.

If artillery forms part of the force, a breach in the parapet may be made with shells, if time enough can be devoted to it; and the opposite ditch being enfiladed, to destroy the palisades, &c., a column has only to wait for a signal to rush forward when these objects have been accomplished; but even in this case, with everything made so smooth, a false Attack, by distracting attention, could not fail to have a good effect.

The Attack on a redoubt, which is a work enclosed all round with a parapet, and supposed to be everywhere of equal strength, will be much the same as that of a flèche. The angles are the weakest points, and the attacks, whether false or real, should direct their march upon them.—See Jones's 'Sieges' and 'Attack of Fort Picurina.'

ATTACK OF A FORTIFIED BUILDING.

The planning and execution of an Attack on a small Military Post, such as a fortified building, will more generally fall to the lot of a young Officer than the comparatively larger operations against a village or redoubt, &c.; but however small the Post may be, if it has been judiciously strengthened and is ably defended, there is opportunity enough for the exercise of both talent and bravery in assaulting it. But let us have a fair fight with no artillery on either side, so that we may see what has to be done, and how certain difficulties which are peculiar to the nature of such an operation are to be surmounted.

First of all we will suppose that with the aid of a good telescope he has made him-

self, and those under him, well acquainted with at least the nature of the external defences, &c. His points of attack are selected, and we will imagine that the little garrison is on the alert as to his intentions, and on the look-out to receive him; moreover that he has a fine sunshine to enliven his proceedings. He divides his force and forms his columns of attack, and the first onset is made on the principle and with the precautions already explained. We will suppose, too, that the obstructions on the outside are surmounted by some of the means detailed in the preceding pages, but here is a great staring house now before him, barricaded and loopholed from top to bottom, and full of people, and a very serious and inhospitable looking thing it is! If an Officer had not been able to procure accurate information of the mode in which this citadel of the post had been prepared for defence, or if he had not sufficient knowledge of localities to enable him to arrange the whole of his plan of operations beforehand, it would be better for him, after a successful attack on the external defences, to throw his force under any cover he could find for a few moments, whilst he took a glance at the remaining works, and was making up his mind what was best to be done; otherwise he would have to risk a wild and uncombined attack, which would probably entail considerable loss, and might be a failure. It would therefore be his object, if possible, to reconnoitre the house all round; but should circumstances induce him to decide on directing his principal attack against some part that he could see from the situation he had first gained, he might take his chance in trusting a false attack on the rear, and leave it to be worked as seemed best for diverting the attention of the defenders. We will suppose that he is opposite an angle of the house, and under cover of some object within 50 or 60 yards of it, and that a little slope in the ground conceals his men when lying down. He observes that one side of the house is flanked by a window, and some loopholes which have been made in an angular portion of the same building, and that on the other side there is a door in the centre covered by a tambour made of rough logs of timber set upright; the windows on both sides are low, but a ditch has been cut in the front to give height, and they are well barricaded with stout timber, loopholes being left for firing through. He has brought with him six ladders 12 feet long, two bags of powder with fuzes attached, and some good workmen with axes, crow-bars, &c.; besides a small reserve, to apply as circumstances may require.

He observes, that if he rushes up in the first instance, directly for the angle of the building, he will be less exposed to fire than if he faced either side, and he decides that this shall be his line; and as strong measures on these occasions are greatly to be commended, he makes up his mind to expend the two bags of powder, one in breaking up the tambour, and the other in blowing open the barricaded window,—then to effect an entrance by means of his ladders, through the window, and to force the door within the tambour by a liberal use of sledge-hammers and crow-bars.

It is of course a great object not to expose men to fire, unless their presence or services can secure some corresponding advantage. He therefore determines only to send those men forward, in the first instance, who will be wanted for fixing the bags of powder and firing them, and a very small detachment to protect them during the operation by watching any particular loophole. To provide against accident, he tells off two men to carry each bag, and two others with lighted portfires for firing them, each party to be accompanied by six men, so that any loopholes which bear upon the situations where the bags are to be fixed may either be silenced or at least have their attention distracted. The success of the operation appears to depend greatly on the adroitness of the men who have charge of the powder, and he therefore has selected some smart fellows who know what they are about, and points out to them what is to be accomplished,—how it is to be effected,—and what particular duty each has to

perform. The columns of assault, too,—the firing party, and a reserve to protect the flanks, or fall back upon in case of accident,—would all be told off, as well as the party for the false Attack; but no movement should be made till every thing was in perfect readiness. He would then explain the general plan of the Attack, and point out the position of the reserve and support, &c.; after which the detachment for the false attack might move off, going by the least exposed route to the rear of the building.

A favourable moment would be chosen for commencing operations. If there were any cover at all, the firing party might quietly distribute themselves opposite the two sides of the house to engage attention, rather than with any hope of doing damage, for loopholes are so narrow that it would require very good and very steady shooting to fire into them from such a distance as we have supposed.

The bags of powder would now be despatched;—the two parties would make a sudden rush up to the angle of the building, and then dividing, there would be nothing left for them but to run the gauntlet as they best could to their separate points, either along the bottom of the little ditch dug to give height to the lower loopholes, or close along its edge. All this would be the business of a minute or two. The bag for blowing in the window would either be propped up against it with a thick stick, or it might be laid on the sill. That for forcing out the timbers of the tambour might be hung upon a single nail, driven in at the time, or the loop would be thrown over the top of one of the timbers. The men for watching the adjoining loopholes should stand as close as they could to them, not exactly in front, but a little on one side, and keep up a constant fire into them, avoiding exposure as much as possible, either from the loopholes on each side, or those which might flank the place where they stood. It would be a needless exposure of men, and the worst of two evils, to make a general attack on loopholes, unless under particular circumstances, where there was only one row, or that something had to be done which would require a party to remain exposed for a considerable time. In cases where there were two or more rows of loopholes, and the defenders had the means of throwing grenades, or rolling shells down from the upper windows, besides giving their fire, the means of attack would not be commensurate with those of the defence, and it would not therefore be prudent to attempt it; but on a limited scale, and when it *must* be done, loopholes may be successfully disputed by superior numbers, if you can get near enough to make pretty sure of firing in; the closer you are, too, the less you are also exposed to any direct fire from others. See Plans to 'Defence of Posts.'

When the bags were fixed, the fuzes would be lighted, and if the men could retire some 10 or 12 yards, close against the wall between any two loopholes, till the explosion took place, it would be safer than attempting to go back to the spot from whence they came. At this juncture,—the axemen,—the party with the ladders,—and one or both storming parties, should be perfectly prepared for springing forward. The moment the explosion takes place they should be up and away. The ladders would either be applied to the windows, as they would be in an escalade; or if the windows were low, they would be of service to form a kind of bridge for crossing the ditch, which might prove an obstacle to getting in. A firing party would watch the opening and the adjacent loopholes, and the storming party would resolutely enter the moment the passage was ready, closely followed by the support, which would at the proper moment advance from its place of concealment.

With respect to the Attack on the Tambour, some little delay might be necessary, as the storming party could not enter till the inner door was forced. The axemen would therefore ply away till they had accomplished its destruction, during which time other men sent for the purpose might recreate in firing through the loopholes, to assist in clearing the passage. When the door was forced, the storming party would

advance, and by a vigorous charge through the opening would overcome all opposition. The entrance gained, a momentary check to collect numbers might take place, and then a determined 'cast forward' in pursuit of the fugitives would be the right thing to do. If the defenders were of a sort 'not to be taken alive,' and were 'making play' for the upper story, where they would be more strongly posted, a sudden rush after them might afford the assailants the opportunity of accompanying them up stairs, and thus finish the affair at once. If the retreat were from one part of the house to another, they should be hotly pursued, without a moment for cogitation or taking breath, and they should be kept going till all opposition had ceased.

On the other hand, if the defenders had succeeded in gaining the upper floor, and the staircases were either destroyed, or too strongly barricaded to be carried by main force, a pretence at lighting a fire in the middle of the *dining-room* would not be without its effect; or any trifling preparations for making a mine in the angle of the *library*, if they did not fire down too much through the ceiling, so as to render it impracticable, would be as likely to bring them to terms as any measure which could be proposed.

If the lower part of a house were very stoutly barricaded, and the assailants were unprovided with bags of powder, for blowing the doors and windows open, an attempt might be made to silence the loopholes which bore on any particular point, and workmen might be employed there in forcing open an entrance, either at a door or window, or in breaking fairly through the wall itself. Or if ladders could be procured, an escalade of the upper windows, which are not usually so strongly fastened, might be attempted; but if denied access at these points, there is no just cause, though there might be impediments, why the roof should not be attacked. Ladders would be brought up and applied in the most convenient and covered situations that could be discovered, and if possible the Assault should be made on several points at once. Having gained the roof, loopholes might be first knocked through at a single blow, and made use of for driving out the defenders,—these would soon be converted into great breaches;—a few grenades might take the duty of a firing party in clearing the front a little,—and an impetuous attack from this perhaps unexpected quarter would be likely enough to succeed.

If the subject of Attack were a church, a prison, or other large building, the same principles and precautions might be applied, only with this difference, that the offensive measures would be so arranged as to keep pace with the increased means of resistance.—See Plans to 'Defence of Posts.'

APPENDIX.—ASSAULT.*

The detail of Special Assaults, as regards the duties of an Engineer Officer, are explained in the articles 'Attack of Fortresses,' 'Attack of Posts,' and 'Escalade;' but the general disposition of the troops, and arrangements for the success of Assaults—whether in the Attack of open, or of walled, or fortified towns; or of intrenchments, fortified positions or camps,—require that the subject be especially submitted to the consideration of persons who may be intrusted with the guidance of such an important operation in the Field.

It is now proposed to suggest such a course as will probably lead to success; or else support the Assault if checked or defeated.

1st. That the Officer commanding and responsible for the operation should be in immediate communication with the troops during the Assault, and be present with the reserve or supporting party.

* By Major-General Lewis, C.B., R.E.

2ndly. The troops destined for this duty should be divided into two portions, *each* equal in strength to three-fourths of the garrison attacked; one portion being the attacking party, and the other half the reserve, or supporting party.

3rdly. Each column of the attacking party will also be subdivided into advance—main body—and support, whatever may be the number of these columns.

4thly. The disposition of the attacking party, as it reaches the point attacked, will be regulated by the Engineer Officer, subject to the Officer commanding; the necessary reconnoissance having been made by them, and the party furnished with tools, ladders, and proper implements, adapted to the circumstances of the moment, as well as being accompanied by a detachment of Sappers.

5thly. The disposition of the reserve, equal, as before observed, to the whole attacking force, should be regulated by the Officer intrusted with the execution of the Assault; and this reserve should be accompanied or not, according to circumstances, by Cavalry and Field Artillery. When these descriptions of force are present, the former should be placed under cover or out of gun-shot, about 1500 yards; the latter should be kept in hand until the attacking party is engaged, when the guns should be spread out on the flanks, and open a vigorous fire upon the works;—the Infantry, brought immediately in rear of the attacking portion under cover, if possible, from fire of grape and musketry, halted until the issue of the first assault is seen.

6thly. It is impossible to regulate an Assault by any minute suggestions for the advance, except to observe that it is usual for each column to attack the salient points of the works, and least defended portions of the place;—to throw out skirmishers and firing parties in front in any cover available, and to keep up a rapid and compact fire upon the defenders;—to follow with the Sappers and Grenadiers to force all obstructions; and then to advance the main body,—the supports of each body being judiciously planted in the rear.

Eventually, as success occurs, and the whole move on, points of security should be taken up, such as the reverse, or the exterior slope, of the works; buildings, walls, as well as gorges, and flanks, which frequently give cover. Men should be planted under an Officer with instructions to take no notice of the pêle-mêle, but to keep up a heavy firing in front; employing the Sappers in intrenching the position taken up by the supporting party, or in collecting waggons, carts, carriages, &c., &c., capable of being made into a barricade.

7thly. Either in the supposition that the success of the Assault is doubtful, or that there is a check, or a repulse,—the reserve, in the first case, to render success doubly sure, should move forward under the Officer commanding the whole force, and relieve the assailants; the original attacking party taking their place as reserve as soon as order can be restored;—the Artillery, brought into position in the openings, between the advancing columns, and directed upon the retreating or resisting forces; and if success is final and complete, the Cavalry, in event of their being employed, will also move forward, either through the openings cleared, or by a detour, if a fortified town, in pursuit.

In the second case, that of a check, the reserve, on the reconnoissance of the Officer commanding, will either move forward in support of the attack, or to cover the retreat, if further perseverance in assault is deemed impracticable; the Artillery and Cavalry being warned as to the intention.

In event of the Assault being repulsed, the reserve, which should be in échellon of corps, having advanced guards in front, will allow the retreating party to move through the intervals, and the advanced guard will endeavour to check the pursuit: if overpowered, they will fall back on the reserve, and the whole may in that manner retreat until beyond gun-shot,—there endeavouring to make a stand, repulse the

garrison, and if possible convert failure into success, if the pursuit has been badly conducted, and without due caution.

The Artillery will retire as soon as it is certain that failure has occurred, and, by a new position, cover the retreat. The Cavalry will also retire, and check any advance of a similar force of the pursuing party.

Lastly. As an important rule in all Assaults, the composition of the forces should be by regiments or corps, and not by detachments: also, each Non-Commissioned Officer should be provided with the means of spiking a gun, for which purpose even an old nail is sufficient.

The points here noticed are of importance in all Assaults, except in partial attacks, as on an outwork, or any particular work in which a lodgement is to be made; local circumstances then regulating the *time*, the *number* employed, and the *mode* of execution.

The necessity of a sufficient reserve, ready and at hand, in support of the assaulting party, each equal to three-fourths of the garrison or force attacked—and of the immediate presence of the Officer commanding, in connection with the attacking force, is inferred from the recollection of our want of success at Buenos Ayres, and at Bergen-op-Zoom. By the arrangements suggested, an unsuccessful attack may be rendered less disastrous; and prevent checks and difficulties when on the point of gaining the object.

It frequently happens that troops led to the Assault obtain a partial success, and then are at a loss how to proceed: no responsible person being present to direct further operations, there is a pause,—the defending party rallies—attacks in its turn,—then comes a retrograde movement—confusion, and finally—defeat. Should, however, *the Reserve, together with the* RESPONSIBLE HEAD, *be at hand,* these untoward events are not likely to occur; for as soon as success is apparent, the Reserve advances, further orders are given, and final success is the probable result.

Indeed, Assaults, *if feasible*, would seldom fail with these precautions; and there are few Posts but what are open to assault, by taking the proper opportunity. And no Officer intrusted with the defence of a place should consider himself secure without unremitting vigilance, except in such cases as works surrounded by deep water, impassable marshes, or by walls or precipices at least 37 feet high; or where the approach is by a narrow causeway, easily watched. G. G. L.

B.

BAROMETER.—The only practical application of this instrument which is now offered is in the determination of heights above the sea level. The memoranda respecting Observation, Registry, &c., are taken from the 'Report of the Committee on Physics and Meteorology, of the Royal Society,' 1840. For the form of Registry, see 'Meteorology.'

The Tables computed by Mr. Howlett, in vol. i. of the Corps Papers, are those which are selected for Barometrical measurements: they are accompanied by the formulæ of Isaac Dalby,* and Sir G. Shuckburgh, as means of approximate check where verification may be desired.

* Commonly called General Roy's formula.

Mr. Howlett's Tables.—In using these, the column letters have been changed to obtain the advantage of significant initials to a greater extent. Under these circumstances the rule given stands thus:

Log. difference of feet in altitude = log. R + Y + Z

R being = log. b − (X + log. B.)

	Upper.	Lower.
Where Barometer is	B	b.
Attached thermometer . . .	A	a.
Detached thermometer . . .	D	d.

Also:

$$\left.\begin{array}{l}\Delta = A \backsim a \\ S = D + d \\ L = \text{latitude}\end{array}\right\} \text{ and } \left\{\begin{array}{lll}X & \text{correspondent in Table to} & \Delta. \\ Y & ,, \quad ,, & S. \\ Z & ,, \quad ,, & L.\end{array}\right.$$

Dalby, and Shuckburgh.

Dalby. Difference of altitude in fathoms

$$= \{10000\, l \mp \cdot 468\, \Delta\} \times \{1 + (M - 32^\circ) \times \cdot 00245\}$$

Shuckburgh. Do. $= \{10000\, l \mp \cdot 44\ \ \Delta\} \times \{1 + (M - 32^\circ) \times \cdot 00243\}$

The sign − is used where the attached thermometer is highest at the lower station.

,, + ,, ,, lowest ,,

In the above, $\left.\begin{array}{l} l = \log. b - \log. B \\ M = \dfrac{D + d}{2}\end{array}\right\}$ the other quantities being as before.

Example.

In lat. 51° 28′.

	Barometer.	Attached thermometer.	Detached thermometer.
Lower	29·862	68°	71°
Upper	26·137	63°	55°

1st. To find R.

Log. b (29·862) . . . . = 1·4751189

Log. B (26·137) . . . . . = 1·4172557

68° − 63° = 5°; and X to 5° = 0·0002171

X + log. B = 1·4174728 } = 1·4174728

0·0576461 = R.

2ndly. Log. R. (0·0576461) . . . . . . = 8·7607315

Y (to D + d = 71° + 55° = 126°) . = 4·8095776

Z to lat. 51° 28′ . . . . = 9·9997466

Log. diff. ft. in altitude . . . . . = 3·5700557 = 3715·8 feet.

By Dalby's formula it is . . . . 3720 feet,

which gives a difference of only 4·2 feet,—a difference that is quite unimportant in ordinary operations: if greater nicety be required, the Barometer is hardly the instrument to be selected.

Table for determining Altitudes with the Barometer. Computed by Samuel B. Howlett, Chief Draftsman, Ordnance, from the formula given by F. Baily, Esq.

Thermometers to the Barometers.			Thermometers in the open air.								Latitude of the place.	
	X		S	Y	S	Y	S	Y	S	Y	L	Z
Δ	Ther. highest at lowest station.	Ther. lowest at lowest station.										
			40°	4·7689067	75°	4·7859208	110°	4·8022936	145°	4·8180714	0°	0·0011689
			41	·7694021	76	·7863973	111	·8027525	146	·8185140	3	·0011624
			42	·7698971	77	·7868733	112	·8032109	147	·8189559	6	·0011433
0°	0·0000000	0·0000000	43	·7703911	78	·7873487	113	·8036687	148	·8193975	9	·0011117
1	·0000434	9·9999566	44	·7708851	79	·7878236	114	·8041261	149	·8198387	12	·0010679
2	·0000869	·9999131	45	·7713785	80	·7882979	115	·8045830	150	·8202794	15	·0010124
3	·0001303	·9998697	46	·7718711	81	·7887719	116	·8050395	151	·8207196	18	·0009459
4	·0001737	·9998262	47	·7723633	82	·7892451	117	·8054953	152	·8211594	21	·0008689
5	·0002171	·9997828	48	·7728548	83	·7897180	118	·8059509	153	·8215988	24	·0007825
6	·0002605	·9997393	49	·7733457	84	·7901903	119	·8064058	154	·8220377	27	·0006874
7	·0003039	·9996959	50	·7738363	85	·7906621	120	·8068604	155	·8224761	30	·0005848
8	·0003473	·9996524	51	·7743261	86	·7911335	121	·8073144	156	·8229141	33	·0004758
9	·0003907	·9996090	52	·7748153	87	·7916042	122	·8077680	157	·8233517	36	·0003615
10	·0004341	·9995655	53	·7753042	88	·7920745	123	·8082211	158	·8237888	39	·0002433
11	·0004775	·9995220	54	·7757925	89	·7925441	124	·8086737	159	·8242256	42	·0001223
12	·0005208	·9994785	55	·7762802	90	·7930135	125	·8091258	160	·8246618	45	·0000000
13	·0005642	·9994350	56	·7767674	91	·7934822	126	·8095776	161	·8250976	48	9·9998775
14	·0006076	·9993916	57	·7772540	92	·7939504	127	·8100287	162	·8255331	49	·9998372
15	·0006510	·9993481	58	·7777400	93	·7944182	128	·8104795	163	·8259680	50	·9997967
16	·0006943	·9993046	59	·7782256	94	·7948854	129	·8109298	164	·8264024	51	·9997566
17	·0007377	·9992611	60	·7787105	95	·7953521	130	·8113796	165	·8268365	52	·9997167
18	·0007810	·9992176	61	·7791949	96	·7958184	131	·8118290	166	·8272701	53	·9996772
19	·0008244	·9991741	62	·7796788	97	·7962841	132	·8122778	167	·8277034	54	·9996381
20	·0008677	·9991305	63	·7801622	98	·7967493	133	·8127263	168	·8281362	55	·9995995
21	·0009111	·9990870	64	·7806450	99	·7972141	134	·8131742	169	·8285685	56	·9995613
22	·0009544	·9990435	65	·7811272	100	·7976784	135	·8136216	170	·8290005	57	·9995237
23	·0009977	·9990000	66	·7816090	101	·7981421	136	·8140688	171	·8294319	58	·9994866
24	·0010411	·9989564	67	·7820902	102	·7986054	137	·8145153	172	·8298629	59	·9994502
25	·0010844	·9989129	68	·7825709	103	·7990681	138	·8149614	173	·8302937	60	·9994144
26	·0011277	·9988694	69	·7830511	104	·7995303	139	·8154070	174	·8307238	63	·9993115
27	·0011710	·9988258	70	·7835306	105	·7999921	140	·8158523	175	·8311536	66	·9992161
28	·0012143	·9987823	71	·7840098	106	·8004533	141	·8162970	176	·8315830	69	·9991293
29	·0012576	·9987387	72	·7844883	107	·8009142	142	·8167413	177	·8320119	75	·9989852
30	·0013009	·9986952	73	·7849664	108	·8013744	143	·8171852	178	·8324404	81	·9988854
31	·0013442	·9986516	74	·7854438	109	·8018343	144	·8176285	179	·8328686		

MEMORANDA FROM THE REPORT OF THE COMMITTEE ON PHYSICS AND METEOROLOGY, OF THE ROYAL SOCIETY, 1840.

Times of Observation.—The purposes of meteorological observations would be most perfectly and most expeditiously obtained by hourly observations throughout the year; but since in the case of private observers in general, and in few public establishments, such a course of unremitting labour cannot be hoped for, it is necessary for general purposes, to select periods at longer intervals, calculated to embrace the extremes of the periodical oscillations to which the pressure of the atmosphere is subject, and to insure that uniformity of system at different stations on which the value of such observations so much depends. It is probable that the hours of 3 A.M., 9 A.M., 3 P.M., and 9 P.M., nearly coincide with the daily maxima and minima of the barometric column at the level of the sea, over a large portion of the globe; and it is desirable that as extensive a comparison as possible should be instituted at these hours. At the Magnetic Observatories it is provided that observations shall be made every second or even hour of Gottingen mean time throughout the twenty-four; so that there at least, and in all others which will act in concert and correspondence with them, the complete diurnal cycle will be satisfactorily observed. It would be useless, and superadding labour to the already extensive task imposed on these establishments, to require observations also at the hours above recommended for general

adoption as *meteorological* hours. They will, therefore, content themselves with filling up the forms furnished them, as adapted to the meteorological hours, with observations made at the nearest *magnetic* hours to those named at each station.

It is not, however, too much to expect that hourly observations should be made, during 24 hours, once in every month, by those who profess to pursue meteorology in a scientific manner; and when this cannot be effected, it is of the utmost importance that they should be made at least four times in the year, namely, at the summer and winter solstices, and at the spring and autumn equinoxes. One of the results of these hourly observations would probably be the indication of the exact times of the daily maxima and minima of pressure at different stations, which, if not found to coincide with the hours provisionally adopted, might ultimately be substituted for them under future directions. At the Magnetic Observatories the instruments will be read off hourly, on the days set apart in each month for the *magnetic term observations*, and the two-hourly system of observation in all cases continuing uninterrupted, will in effect furnish corresponding observations on all other days, whether arbitrarily chosen to suit private convenience, or in pursuance of the system about to be proposed in the subsequent paragraphs.

Hourly observations at the equinoxes and solstices have been already instituted at numerous points both of Europe and America, at the suggestion of Sir John Herschel, whose directions should be strictly attended to. They are as follows:

The days fixed upon for these observations are the 21st of March, the 21st of June, the 21st of September, and the 21st of December, being those, or immediately adjoining to those, of the equinoxes and solstices in which the solar influence is either stationary or in a state of most rapid variation. *But should any one of those 21st days fall on Sunday, then it will be understood that the observations are to be deferred till the next day, the 22nd.* The observation at each station should commence at 6 o'clock A.M. of the appointed days, and terminate at 6 A.M. of the days following, according to the usual reckoning of time at the place.

The commencement of each hour should be chosen, and every such series of observations accompanied by a notice of the means used to obtain the time, and when practicable, by some observation of an astronomical nature by which the time can be ascertained within a minute or two.

The Committee now propose to extend these observations in regular series to the 21st of every month, with the same reservation with regard to Sundays.

Travellers provided with meteorological instruments, who may be stationary on any of these days, may use them with advantage on such opportunities. Such as may ascend high mountains are recommended, *cæteris paribus*, to choose one of these days as affording a greater probability of securing a complete series of corresponding observations than any other; for which reason these observations cannot be too strongly recommended to *residents* in mountainous countries. The geologist, nay, even the surveyor, may find his account in traversing his field, barometer in hand, on one of these days, provided he have reason to presume that there exist observers in its neighbourhood who take a part in these observations.

It is to be hoped that to scientific meteorological observers the six-hourly observations may not be found to be impracticable throughout the year; but in any case where it may be impossible to observe regularly at 3 A.M., an effort should be made to include the hour on the days of the new and full moon, and quadratures, or at least on the days of the new and full moon;—as it must be borne in mind, that in what concerns the great meteorological questions on which the most important features of the subject depend, the night is quite as important as the day, and has been hitherto far too much neglected.

Whatever hours, however, may be selected for the regular series of observations, the greatest care should be taken not to insert in the register anything deduced by interpolation from observations made at other hours, or anything, in short, but what has been actually observed.

It is much to be wished that occasional observations may be made under remarkable circumstances, such as during great rises or great falls of the barometer, at the period of great storms, earthquakes, &c.; but such observations should be registered apart.

The barometer should be placed in an apartment subject to as little variation of temperature as possible, and in a good light; and to facilitate night observations, an arrangement should be made for placing behind it a light screened by a sheet of white paper, or other diaphanous substance. Great care should be taken to fix it in a perpendicular position by the plumb-line. Its height must be carefully ascertained above some permanent and easily-recoverable mark, either in the building in which it is situated, or in some more permanent building, or rock in its immediate vicinity; and no pains should be spared to ascertain the relation which such mark may bear to the level of high and of low water at spring tides, and ultimately to the mean level of the sea.

Changes in the adjustments of meteorological instruments should be most carefully avoided; but whenever any alterations may be absolutely necessary, they should be made with all deliberation, scrupulously noticed in the register, and the exact amount of the change thence arising in the reading of the instrument under re-adjustment ascertained. As far as possible, registers of meteorological observations should be complete; but if, by unavoidable circumstances of absence, or from other causes, blanks occur, no attempts to fill them up by general recollection, or by the apparent course of the numbers before and after, should ever be made.

The Observatories established by the Government are furnished with two barometers each, of Newman's construction—the one a standard, and the other portable; and they are accompanied by accurate directions for fixing and observing them.

The standard instrument is of large dimensions, its tube being of the diameter of 0·6 inch. It requires two adjustments: 1st. The whole scale, which is of brass, is moveable, and terminates in an ivory point, which is carefully brought down to the surface of the mercury in the cistern, and the two are known to be accurately in contact when the actual point and its reflection appear just to touch one another. The scale is laid off from this point from an authentic standard, at the temperature of 32°.

2nd. The second adjustment is that of the vernier, in which the upper part of the scale terminates, to the surface of the mercury in the tube. For this, both the back and front edge are made to coincide, and brought down so as to form a tangent to the curve, and just to exclude the light between them at the point of contact. In making both these adjustments, it is desirable that the eye should be assisted by a magnifying glass. Before the observation is made, the instrument should be slightly tapped, to free the mercury from any adhesion to the glass; but any violent oscillation should be avoided.

The Portable Barometer has only one adjustment, namely, that of the vernier to the upper surface of the mercury in the tube, which adjustment must be effected with the same precaution as in the case of the standard instrument.

This first reading may be entered in the column prepared for it in the register, and beside it the temperature of the mercury carefully read off from the thermometer which dips into the cistern.

As in the case of the Standard Barometer the first measure is taken immediately

from the surface of the mercury in the cistern, it requires no correction for the different capacities of the tube and cistern. Neither does it require any correction for capillary action, as the large diameter of the tube renders this correction inappreciable.

The Portable Barometer, however, requires corrections for both these circumstances. For the purpose of the former, the *neutral point* is marked upon each instrument, or that particular height which, in the construction of the instrument, has been actually measured from the surface of the mercury in the cistern.

It is obvious that in almost every case the mercury will stand either above or below the neutral point: if above, a portion of the mercury must have left the cistern to enter the tube, and consequently must have lowered the surface in the cistern: if below, a quantity of mercury must have left the tube, and, entering the cistern, raised the level of the mercury in it. For the correction of observations for this circumstance, the relation of the capacities of the tube and cistern have been experimentally ascertained, and are marked upon the instrument: thus *capacity* $\frac{1}{50}$th indicates that for every inch of elevation of the mercury in the tube, that in the cistern will be depressed one 50th of an inch. Thus, when the mercury in the tube is above the neutral point, the difference between it and the neutral point is to be divided by the capacity, and the quotient being added to the observed height, the result will be the corrected height. Or if the mercury at the time of observation should be below the neutral point, the difference of the two is to be divided as before, and the quotient to be subtracted from the observed height. Thus, suppose the capacity to be $\frac{1}{50}$th, the neutral point 30 inches, and the observed height 30·500 inches, the difference is 0·5 inch, which, divided by 50, gives 0·01 inch to be added to the observed height, producing 30·51, the corrected height; or if the observed height be 29 inches, the difference, 1 inch, divided by 50, gives ·02 inch to be subtracted from the observed height, giving 28·980 inches for the corrected height.

The second correction required is for the capillary action of the tube, the effect of which is constantly to depress the mercury in the tube by a certain quantity inversely proportioned to the diameter of the tube. In the instruments furnished to the fixed Observatories the amount has been experimentally determined during their construction, and marked upon the instrument; the quantity is always to be added to the height of the mercurial column, previously corrected as before. For the convenience of those who may have barometers, the capillary action of which has not been so determined, a Table of the corrections for tubes of different diameters is given.

The Marine Barometers differ in nothing from the other Portable Barometers but in the mode of their suspension and the necessary contraction of the tubes to prevent oscillation from the motion of the ship, and require the same corrections.

When these two corrections have been made in the first reading of the Portable Barometer, it should agree with the direct observation of the Standard Barometer; and it is very desirable that frequent comparative observations should be made of the two instruments, in order to ascertain whether there may be any permanent difference between them. Should this be the case, the amount may be marked upon the instrument, and allowed for as an index error, in order that, if an accident should happen to one, the other may be substituted for it without detriment to the regular series of observations.

It is to be presumed that the Portable Barometer will frequently be employed in ascertaining the altitude of remarkable points in the vicinity of the Observatory.

The instruments furnished to the Observatories have been all independently graduated and compared with the standard of the Royal Society; and in all cases it

is desirable that such a comparison should be made with some standard instrument of authority, directly, or by means of a good Portable Barometer. In making such comparisons, all that is necessary is to record five or ten simultaneous readings of both instruments, deliberately made, at intervals of a few minutes from each other, after, at least, an hour's quiet exposure, side by side, that they may have the same temperature. If compared by two observers, each should read off his own barometer in his usual manner, then each should verify the other's result. By this means the zero of one standard may be transported over all the world, and that of others compared with it ascertained. To do so, however, with perfect effect, requires the utmost care in the transport of the intermediate barometer, and is by no means an operation either of trifling import or of hurried or negligent performance: some of the greatest questions in meteorology depend on its due execution.

The next correction, and, in some respects, the most important of all, is that due to the temperature of the mercury in the barometer tube at the time of observation. To obtain this, every barometer requires to have attached to it a thermometer, which in the instruments furnished to the Observatories dips into the mercury in the cistern, and this must be read and registered at each observation of the barometer. A Table (II.) is appended, calculated by Professor Schumacher, which gives for every degree of the thermometer, and every half-inch of the barometer, the proper quantity to be added or subtracted for the reduction of the observed height to the standard temperature of 32° Fahrenheit.

It must, however, be observed, that this Table is only calculated for barometers whose scales are engraven upon a rod or plate of brass reaching from the level of the mercury to the vernier. In many barometers the scale is engraved upon a short plate of brass fixed upon the wooden frame of the instrument, and the compound expansion of the two substances can only be guessed at, but must be obviously less than if the whole length had been of brass. As a near approximation for such imperfect instruments, another Table (III.) has been given, in which the lesser expansion of glass has been substituted for that of brass. No scientific observer, however, would willingly use such an instrument.

Although all these corrections are necessary for the strict *reduction* of registered observations, they ought not to be applied to individual observations previously to registry. In the blank forms of register furnished to the Observatories, one sheet is devoted to uncorrected observations, and a second to the corrected; and it is much to be wished that the proper reductions should be made as soon after the observations as possible.

TABLE I.

Correction to be added to Barometers for Capillary Action.

Diameter of tube.	Correction for Unboiled tubes.	Correction for Boiled tubes.
inch.	inch.	inch.
0·60	0·004	0·002
0·50	0·007	0·003
0·45	0·010	0·005
0·40	0·014	0·007
0·35	0·020	0·010
0·30	0·028	0·014
0·25	0·040	0·020
0·20	0·060	0·029
0·15	0·088	0·044
0·10	0·142	0·070

TABLE II.

Correction to be applied to Barometers with brass scales, *extending from the Cistern to the top of the Mercurial Column, to reduce the observation to* 32° *Fahrenheit.*

Temp.	Inches.							
	20	20·5	21	21·5	22	22·5	23	23·5
°	+	+	+	+	+	+	+	+
0	·051	·053	·054	·055	·056	·058	·059	·060
1	·049	·051	·052	·053	·054	·056	·057	·058
2	·048	·049	·050	·051	·052	·054	·055	·056
3	·046	·047	·048	·049	·050	·052	·053	·054
4	·044	·045	·046	·047	·048	·050	·051	·052
5	·042	·043	·044	·045	·046	·048	·049	·050
6	·040	·042	·042	·044	·044	·046	·047	·048
7	·039	·040	·041	·042	·042	·044	·044	·046
8	·037	·038	·039	·040	·041	·041	·042	·043
9	·035	·036	·037	·038	·039	·039	·040	·041
10	·033	·034	·035	·036	·037	·037	·038	·039
11	·031	·032	·033	·034	·035	·035	·036	·037
12	·030	·030	·031	·032	·033	·033	·034	·035
13	·028	·029	·029	·030	·031	·031	·032	·033
14	·026	·027	·027	·028	·029	·029	·030	·031
15	·024	·025	·026	·026	·027	·027	·028	·029
16	·022	·023	·024	·024	·025	·025	·026	·026
17	·021	·021	·022	·022	·023	·023	·024	·024
18	·019	·019	·020	·020	·021	·021	·022	·022
19	·017	·018	·018	·018	·019	·019	·020	·020
20	·015	·016	·016	·016	·017	·017	·018	·018
21	·014	·014	·014	·015	·015	·015	·015	·016
22	·012	·012	·012	·013	·013	·013	·013	·014
23	·010	·010	·010	·011	·011	·011	·011	·012
24	·008	·008	·009	·009	·009	·009	·009	·010
25	·006	·007	·007	·007	·007	·007	·007	·007
26	·005	·005	·005	·005	·005	·005	·005	·005
27	·003	·003	·003	·003	·003	·003	·003	·003
28	·001	·001	·001	·001	·001	·001	·001	·001
	—	—	—	—	—	—	—	—
29	·001	·001	·001	·001	·001	·001	·001	·001
30	·003	·003	·003	·003	·003	·003	·003	·003
31	·005	·005	·005	·005	·005	·005	·005	·005
32	·006	·006	·007	·007	·007	·007	·007	·007
33	·008	·008	·008	·009	·009	·009	·009	·010
34	·010	·010	·010	·011	·011	·011	·011	·012
35	·012	·012	·012	·013	·013	·013	·013	·014
36	·013	·014	·014	·014	·015	·015	·016	·016
37	·015	·016	·016	·016	·017	·017	·018	·018
38	·017	·017	·018	·018	·019	·019	·020	·020
39	·019	·019	·020	·020	·021	·021	·022	·022
40	·021	·021	·022	·022	·023	·023	·024	·024
41	·022	·023	·024	·024	·025	·025	·026	·026
42	·024	·025	·025	·026	·027	·027	·028	·028
43	·026	·027	·027	·028	·029	·029	·030	·031
44	·028	·029	·029	·030	·031	·031	·032	·033
45	·030	·030	·031	·032	·033	·033	·034	·035
46	·031	·032	·033	·034	·035	·035	·036	·037
47	·033	·034	·035	·036	·036	·037	·038	·039
48	·035	·036	·037	·038	·038	·039	·040	·041
49	·037	·038	·039	·040	·040	·041	·042	·043
50	·038	·039	·040	·041	·042	·043	·044	·045

Temp.	Inches.							
	20	20·5	21	21·5	22	22·5	23	23·5
°	—	—	—	—	—	—	—	—
51	·040	·041	·042	·043	·044	·045	·046	·047
52	·042	·043	·044	·045	·046	·047	·048	·049
53	·044	·045	·046	·047	·048	·049	·050	·052
54	·046	·047	·048	·049	·050	·051	·052	·054
55	·047	·049	·050	·051	·052	·053	·055	·056
56	·049	·050	·052	·053	·054	·055	·057	·058
57	·051	·052	·054	·055	·056	·057	·059	·060
58	·053	·054	·055	·057	·058	·059	·061	·062
59	·055	·056	·057	·059	·060	·061	·063	·064
60	·056	·058	·059	·061	·062	·063	·065	·066
61	·058	·060	·061	·062	·064	·065	·067	·068
62	·060	·061	·063	·064	·066	·067	·069	·070
63	·062	·063	·065	·066	·068	·069	·071	·072
64	·063	·065	·067	·068	·070	·071	·073	·075
65	·065	·667	·068	·070	·072	·073	·075	·077
66	·067	·069	·070	·072	·074	·075	·077	·079
67	·069	·071	·072	·074	·076	·077	·079	·081
68	·071	·072	·074	·076	·078	·079	·081	·083
69	·072	·074	·076	·078	·080	·081	·083	·085
70	·074	·076	·078	·080	·082	·083	·085	·087
71	·076	·078	·080	·082	·083	·085	·087	·089
72	·078	·080	·082	·084	·085	·087	·089	·091
73	·079	·081	·083	·085	·087	·089	·091	·093
74	·081	·083	·085	·087	·089	·091	·093	·095
75	·083	·085	·087	·089	·091	·093	·095	·098
76	·085	·087	·089	·091	·093	·095	·097	·100
77	·087	·089	·091	·093	·095	·097	·100	·102
78	·088	·091	·093	·095	·097	·099	·102	·104
79	·090	·092	·095	·097	·099	·101	·104	·106
80	·092	·094	·096	·099	·101	·103	·106	·108
81	·094	·096	·098	·101	·103	·105	·108	·110
82	·095	·098	·100	·103	·105	·107	·110	·112
83	·097	·100	·102	·104	·107	·109	·112	·114
84	·099	·101	·104	·106	·109	·111	·114	·116
85	·101	·103	·106	·108	·111	·113	·116	·118
86	·103	·105	·108	·110	·113	·115	·118	·120
87	·104	·107	·109	·112	·115	·117	·120	·123
88	·106	·109	·111	·114	·117	·119	·122	·125
89	·108	·111	·113	·116	·119	·121	·124	·127
90	·110	·112	·115	·118	·121	·123	·126	·129
91	·111	·114	·117	·120	·122	·125	·128	·131
92	·113	·116	·119	·122	·124	·127	·130	·133
93	·115	·118	·121	·124	·126	·129	·132	·135
94	·117	·120	·122	·125	·128	·131	·134	·137
95	·118	·121	·124	·127	·130	·133	·136	·139
96	·120	·123	·126	·129	·132	·135	·138	·141
97	·122	·125	·128	·131	·134	·137	·140	·143
98	·124	·127	·130	·133	·136	·139	·142	·145
99	·125	·129	·132	·135	·138	·141	·144	·147
100	·127	·130	·134	·137	·140	·143	·146	·150

TABLE II.—*continued.*

Temp.	Inches. 24	24·5	25	25·5	26	26·5	27	27·5	Temp.
°	+	+	+	+	+	+	+	+	°
0	·061	·063	·064	·065	·067	·068	·069	·071	0
1	·059	·061	·062	·063	·064	·065	·067	·068	1
2	·057	·058	·060	·061	·062	·063	·064	·066	2
3	·055	·056	·057	·059	·060	·061	·062	·063	3
4	·053	·054	·055	·056	·057	·058	·059	·061	4
5	·051	·052	·053	·054	·055	·056	·057	·058	5
6	·049	·050	·051	·052	·053	·054	·055	·056	6
7	·046	·047	·048	·049	·050	·051	·052	·053	7
8	·044	·045	·046	·047	·048	·049	·050	·051	8
9	·042	·043	·044	·045	·046	·046	·047	·048	9
10	·040	·041	·042	·042	·043	·044	·045	·046	10
11	·038	·039	·039	·040	·041	·042	·042	·043	11
12	·036	·036	·037	·038	·039	·039	·040	·041	12
13	·033	·034	·035	·036	·036	·037	·038	·038	13
14	·031	·032	·033	·033	·034	·035	·035	·036	14
15	·029	·030	·030	·031	·032	·032	·033	·033	15
16	·027	·028	·028	·029	·029	·030	·030	·031	16
17	·025	·025	·026	·026	·027	·027	·028	·028	17
18	·023	·023	·024	·024	·025	·025	·025	·026	18
19	·021	·021	·021	·022	·022	·023	·023	·024	19
20	·018	·019	·019	·020	·020	·020	·021	·021	20
21	·016	·017	·017	·017	·018	·018	·018	·019	21
22	·014	·014	·015	·015	·015	·016	·016	·016	22
23	·012	·012	·012	·013	·013	·013	·013	·014	23
24	·010	·010	·010	·010	·011	·011	·011	·011	24
25	·008	·008	·008	·008	·008	·008	·009	·009	25
26	·005	·006	·006	·006	·006	·006	·006	·006	26
27	·003	·003	·003	·003	·004	·004	·004	·004	27
28	·001	·001	·001	·001	·001	·001	·001	·001	28
	—	—	—	—	—	—	—	—	
29	·001	·001	·001	·001	·001	·001	·001	·001	29
30	·003	·003	·003	·004	·004	·004	·004	·004	30
31	·005	·006	·006	·006	·006	·006	·006	·006	31
32	·008	·008	·008	·008	·008	·008	·009	·009	32
33	·010	·010	·010	·010	·011	·011	·011	·011	33
34	·012	·012	·012	·013	·013	·013	·013	·014	34
35	·014	·014	·015	·015	·015	·015	·016	·016	35
36	·016	·017	·017	·017	·017	·018	·018	·019	36
37	·018	·019	·019	·019	·020	·020	·021	·021	37
38	·020	·021	·021	·022	·022	·023	·023	·023	38
39	·023	·023	·024	·024	·024	·025	·025	·026	39
40	·025	·025	·026	·026	·027	·027	·028	·028	40
41	·027	·027	·028	·029	·029	·030	·030	·031	41
42	·029	·030	·030	·031	·031	·032	·033	·033	42
43	·031	·032	·032	·033	·034	·034	·035	·036	43
44	·033	·034	·035	·035	·036	·037	·037	·038	44
45	·035	·036	·037	·038	·038	·039	·040	·041	45
46	·038	·038	·039	·040	·041	·042	·042	·043	46
47	·040	·041	·041	·042	·043	·044	·045	·046	47
48	·042	·043	·044	·045	·045	·046	·047	·048	48
49	·044	·045	·046	·047	·048	·049	·050	·050	49
50	·046	·047	·048	·049	·050	·051	·052	·053	50

Temp.	Inches. 24	24·5	25	25·5	26	26·5	27	27·5	Temp.
°	—	—	—	—	—	—	—	—	°
51	·048	·049	·050	·051	·052	·053	·054	·055	51
52	·050	·052	·053	·054	·055	·056	·057	·058	52
53	·053	·054	·055	·056	·057	·058	·059	·060	53
54	·055	·056	·057	·058	·059	·060	·062	·063	54
55	·057	·058	·059	·060	·062	·063	·064	·065	55
56	·059	·060	·061	·063	·064	·065	·066	·068	56
57	·061	·062	·064	·065	·066	·068	·069	·070	57
58	·063	·065	·066	·067	·069	·070	·071	·073	58
59	·065	·067	·068	·070	·071	·072	·074	·075	59
60	·068	·069	·070	·072	·073	·075	·076	·077	60
61	·070	·071	·073	·074	·075	·077	·078	·080	61
62	·072	·073	·075	·076	·078	·079	·081	·082	62
63	·074	·076	·077	·079	·080	·082	·083	·085	63
64	·076	·078	·079	·081	·082	·084	·086	·087	64
65	·078	·080	·082	·083	·085	·086	·088	·090	65
66	·080	·082	·084	·085	·087	·089	·090	·092	66
67	·083	·084	·086	·088	·089	·091	·093	·095	67
68	·085	·086	·088	·090	·092	·094	·095	·097	68
69	·087	·089	·090	·092	·094	·096	·098	·100	69
70	·089	·091	·093	·095	·096	·098	·100	·102	70
71	·091	·093	·095	·097	·099	·101	·102	·104	71
72	·093	·095	·097	·099	·101	·103	·105	·107	72
73	·095	·097	·099	·101	·103	·105	·107	·109	73
74	·097	·099	·102	·104	·106	·108	·110	·112	74
75	·100	·102	·104	·106	·108	·110	·112	·114	75
76	·102	·104	·106	·108	·110	·112	·114	·117	76
77	·104	·106	·108	·110	·112	·115	·117	·119	77
78	·106	·108	·110	·113	·115	·117	·119	·122	78
79	·108	·110	·113	·115	·117	·119	·122	·124	79
80	·110	·113	·115	·117	·119	·122	·124	·126	80
81	·112	·115	·117	·119	·122	·124	·126	·129	81
82	·114	·117	·119	·122	·124	·126	·129	·131	82
83	·117	·119	·121	·124	·126	·129	·131	·134	83
84	·119	·121	·124	·126	·129	·131	·134	·136	84
85	·121	·123	·126	·128	·131	·133	·136	·139	85
86	·123	·126	·128	·131	·133	·136	·138	·141	86
87	·125	·128	·130	·133	·136	·138	·141	·143	87
88	·127	·130	·133	·135	·138	·141	·143	·146	88
89	·129	·132	·135	·137	·140	·143	·146	·148	89
90	·131	·134	·137	·140	·142	·145	·148	·151	90
91	·134	·136	·139	·142	·145	·148	·150	·153	91
92	·136	·139	·141	·144	·147	·150	·153	·156	92
93	·138	·141	·144	·147	·149	·152	·155	·158	93
94	·140	·143	·146	·149	·152	·155	·157	·161	94
95	·142	·145	·148	·151	·154	·157	·160	·163	95
96	·144	·147	·150	·153	·156	·159	·162	·165	96
97	·146	·149	·152	·156	·159	·162	·165	·168	97
98	·148	·152	·155	·158	·161	·164	·167	·170	98
99	·151	·154	·157	·160	·163	·166	·169	·173	99
100	·153	·156	·159	·162	·165	·169	·172	·175	100

Temp.	Inches.							Temp.
	28	28·5	29	29·5	30	30·5	31	
°	+	+	+	+	+	+	+	°
0	·072	·073	·074	·076	·077	·078	·080	0
1	·069	·071	·072	·073	·074	·076	·077	1
2	·067	·068	·069	·070	·072	·073	·074	2
3	·064	·065	·067	·068	·069	·070	·071	3
4	·062	·063	·064	·065	·066	·067	·068	4
5	·059	·060	·061	·062	·063	·065	·066	5
6	·057	·058	·059	·060	·061	·062	·063	6
7	·054	·055	·056	·057	·058	·059	·060	7
8	·052	·053	·054	·054	·055	·056	·057	8
9	·049	·050	·051	·052	·053	·054	·054	9
10	·047	·047	·048	·049	·050	·051	·052	10
11	·044	·045	·046	·046	·047	·048	·049	11
12	·042	·042	·043	·044	·045	·045	·046	12
13	·039	·040	·040	·041	·042	·043	·043	13
14	·037	·037	·038	·038	·039	·040	·040	14
15	·034	·035	·035	·036	·036	·037	·038	15
16	·032	·032	·033	·033	·034	·034	·035	16
17	·029	·030	·030	·031	·031	·032	·032	17
18	·026	·027	·027	·028	·028	·029	·029	18
19	·024	·024	·025	·025	·026	·026	·027	19
20	·021	·022	·022	·023	·023	·023	·024	20
21	·019	·019	·020	·020	·020	·021	·021	21
22	·016	·017	·017	·017	·018	·018	·018	22
23	·014	·014	·014	·015	·015	·015	·015	23
24	·011	·012	·012	·012	·012	·012	·013	24
25	·009	·009	·009	·009	·009	·010	·010	25
26	·006	·006	·007	·007	·007	·007	·007	26
27	·004	·004	·004	·004	·004	·004	·004	27
28	·001	·001	·001	·001	·001	·001	·001	28
	—	—	—	—	—	—	—	
29	·001	·001	·001	·001	·001	·001	·001	29
30	·004	·004	·004	·004	·004	·004	·004	30
31	·006	·006	·007	·007	·007	·007	·007	31
32	·009	·009	·009	·009	·009	·010	·010	32
33	·011	·012	·012	·012	·012	·012	·012	33
34	·014	·014	·014	·015	·015	·015	·015	34
35	·016	·017	·017	·017	·018	·018	·018	35
36	·019	·019	·020	·020	·020	·021	·021	36
37	·021	·022	·022	·022	·023	·023	·024	37
38	·024	·024	·025	·025	·026	·026	·026	38
39	·026	·027	·027	·028	·028	·029	·029	39
40	·029	·029	·030	·030	·031	·031	·032	40
41	·031	·032	·033	·033	·034	·034	·035	41
42	·034	·034	·035	·036	·036	·037	·037	42
43	·036	·037	·038	·038	·039	·040	·040	43
44	·039	·040	·040	·041	·042	·042	·043	44
45	·041	·042	·043	·044	·044	·045	·046	45
46	·044	·045	·045	·046	·047	·048	·049	46
47	·046	·047	·048	·049	·050	·051	·051	47
48	·049	·050	·051	·052	·052	·053	·054	48
49	·051	·052	·053	·054	·055	·056	·057	49
50	·054	·055	·056	·057	·058	·059	·060	50

Temp.	Inches.							Temp.
	28	28·5	29	29·5	30	30·5	31	
°	—	—	—	—	—	—	—	°
51	·056	·057	·058	·059	·060	·061	·062	51
52	·059	·060	·061	·062	·063	·064	·065	52
53	·061	·063	·064	·065	·066	·067	·068	53
54	·064	·065	·066	·067	·068	·070	·071	54
55	·066	·068	·069	·070	·071	·072	·073	55
56	·069	·070	·071	·073	·074	·075	·076	56
57	·071	·073	·074	·075	·076	·078	·079	57
58	·074	·075	·077	·078	·079	·081	·082	58
59	·076	·078	·079	·080	·082	·083	·085	59
60	·079	·080	·082	·083	·085	·086	·087	60
61	·081	·083	·084	·086	·087	·089	·090	61
62	·084	·085	·087	·088	·090	·091	·093	62
63	·086	·088	·089	·091	·093	·094	·096	63
64	·089	·090	·092	·094	·095	·097	·098	64
65	·091	·093	·095	·096	·098	·100	·101	65
66	·094	·096	·097	·099	·101	·102	·104	66
67	·096	·098	·100	·102	·103	·105	·107	67
68	·099	·101	·102	·104	·106	·108	·109	68
69	·101	·103	·105	·107	·109	·110	·112	69
70	·104	·106	·108	·109	·111	·113	·115	70
71	·106	·108	·110	·112	·114	·116	·118	71
72	·109	·111	·113	·115	·117	·119	·120	72
73	·111	·113	·115	·117	·119	·121	·123	73
74	·114	·116	·118	·120	·122	·124	·126	74
75	·116	·118	·120	·122	·125	·127	·129	75
76	·119	·121	·123	·125	·127	·129	·131	76
77	·121	·123	·126	·128	·130	·132	·134	77
78	·124	·126	·128	·130	·133	·135	·137	78
79	·126	·128	·131	·133	·135	·137	·140	79
80	·129	·131	·133	·136	·138	·140	·143	80
81	·131	·134	·136	·138	·141	·143	·145	81
82	·134	·136	·138	·141	·143	·146	·148	82
83	·136	·139	·141	·143	·146	·148	·151	83
84	·139	·141	·144	·146	·149	·151	·154	84
85	·141	·144	·146	·149	·151	·154	·156	85
86	·144	·146	·149	·151	·154	·156	·159	86
87	·146	·149	·151	·154	·157	·159	·162	87
88	·149	·151	·154	·157	·159	·162	·165	88
89	·151	·154	·156	·159	·162	·165	·167	89
90	·153	·156	·159	·162	·164	·167	·170	90
91	·156	·159	·162	·165	·167	·170	·173	91
92	·158	·161	·164	·167	·170	·172	·175	92
93	·161	·164	·167	·170	·172	·175	·178	93
94	·163	·166	·169	·172	·175	·177	·180	94
95	·166	·169	·172	·175	·178	·180	·183	95
96	·168	·171	·174	·178	·181	·183	·186	96
97	·171	·174	·177	·180	·183	·186	·189	97
98	·173	·176	·179	·183	·186	·188	·191	98
99	·176	·179	·182	·185	·188	·191	·194	99
100	·178	·181	·184	·188	·191	·194	·197	100

TABLE III.

Correction to be applied to Barometers, the scales of which are engraven on glass, *to reduce the observations to* 32° *Fahrenheit.*

Temp.	Inches. 28·0	Inches. 28·5	Inches. 29·0	Inches. 29·5	Inches. 30·0	Inches. 30·5	Inches. 31·0	Inches. 31·5
25	+·017	+·017	+·017	+·018	+·018	+·018	+·019	+·019
30	+·005	+·005	+·005	+·005	+·005	+·005	+·005	+·005
35	−·007	−·007	−·007	−·008	−·008	−·008	−·008	−·008
40	−·019	−·020	−·020	−·020	−·021	−·021	−·021	−·022
45	−·031	−·032	−·032	−·033	−·033	−·034	−·035	−·036
50	−·043	−·044	−·045	−·046	−·046	−·047	−·048	−·049
55	−·055	−·056	−·057	−·058	−·059	−·060	−·061	−·062
60	−·067	−·068	−·069	−·071	−·072	−·074	−·075	−·076
65	−·079	−·081	−·082	−·083	−·085	−·086	−·088	−·089
70	−·091	−·093	−·094	−·096	−·098	−·100	−·101	−·103
75	−·103	−·105	−·106	−·109	−·111	−·114	−·116	−·118

R. J. N.

BARREL.—See 'BRIDGE, CASK.'

BARRICADE—considered as a *temporary* obstruction to attack,—from the occupation of buildings converted into strong defensible posts, in the field,—to the hasty arrangements against insurrectionary movements in towns.

Reserving the former for its more appropriate heading, 'Defence of Posts,' reference will now only be made to the latter, and in the original sense of 'Barricade,' as derived from 'Barrique,' in allusion to the defences of the streets of Paris during the disturbances of the League, &c.

The character of the expected attack will determine the most general arrangement for the barricade. If from the town, or country, only, the line of defence will be single; if from both, the points to be defended must be considered accordingly; not so much by double lines, as by being ready, front and rear, at those points.

In barricading a town, in whole, or part, it should be considered as *a position*, and every attention paid to the control of communications, to the stock of ammunition and provisions, and to the reduction of the space to be enclosed to the smallest advisable limits, so as to economize time, materials, and forces necessary for the more passive sort of defence, leaving as many as may be for that of an active character.

In all cases, the general maxim for field defences, of never leaving obstacles unsupported, must be borne in mind; especially, as in streets, where it may not be always possible to man the barriers, owing to the fire of the neighbouring houses, and when they can only be held by occupying the contiguous and flanking dwellings.

BARRICADING IN TOWNS.

The Barricade may consist of moveable portions of palisading, (figs. 1, 2,) made musket-proof by sand-bags. In some recent arrangements for defence, in Ireland, the following was the detail:

Per 5-ft. width of Street.

1 Bay of palisading, 5 ft. wide.
70 Bushel sand-bags, filled.
1 Mallet, hand.
1 Block, wood, 12″ × 6″ × 3″ } to rectify any unevenness in the streets.
1 Wedge, do. 12″ × 3″ }
1 Hand hatchet.
1 Sapper, 4 of the Line.
1 large cart, to contain the above materials.

Per Barrier.

1 Crow-bar.
1 Sledge hammer.
1 Felling-axe.
1 Pioneer.

Figs. 6 and 7 shew the mode in which these bays should be arranged.

Chevaux-de-frize were required, as at *a*, fig. 6, for barriers to those streets where thoroughfare was to be permitted; or in front of the parapets of sand-bags, with which blind alleys, or other suspicious openings, were to be closed.

In fig. 7, a recess of about 10 ft. is allowed, not to interfere with passengers, or be interrupted by them.

The above cannot in general be managed without some warning, as the equipment requires an amount of labour, material, and transport, not easily commanded; since each 5-ft. bay of palisading weighs about 450 lbs., and measures upwards of 20 cubic feet in transport. The following series of Barricade afford means of closing openings in various ways, most of them practicable under all circumstances.

1. Palisading; moveable, as above, or fixed, as usual.
2. Stockade* of trees; from esplanades, avenues, canals, gardens, &c. } loopholed; the bottom of the loophole not less than 8 feet above the ground outside.
3. Stockade of squared baulk; from the timber-yards. }
4. Abattis; with, or without, parapet of earth and ditch, behind.
5. Parapet of baulk, or of logs roughly trimmed,—provided they reach across the road, and either enter the walls, or can be well secured to them.
6. Barrels, hampers, or sacks filled with earth, as a parapet; a ditch in front; avoiding parapets of paving-stones as much as possible.
7. Earthen parapets, with plank revetments, supported by posts.
8. Carts, waggons, &c., jammed and lashed together.
9. Iron railing, removed bodily in convenient lengths, from enclosure walls, areas, &c.
10. Chevaux-de-frize: this, only occasionally, for particular points; especially for closing passages in the main Barricades, as a sort of temporary gate.
11. Sand-bag parapets,—with chevaux-de-frize in front, and loopholed above: this also is only an occasional resource.

&c., &c., &c.

Open iron gates are best rendered proof by oaken mantlets. See figs. 3, 4, 5.

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* See 'Stockade.'

The following are the thicknesses of ordinary materials, as determined by recent experiments,—

Walls,
- Brick, 1 brick thick,
- Granite, Compact Limestone, Ditto Sandstone } 6 inches, solid stone,
- Cob (clay and straw) 9 inches thick,

Width of 1-bushel sand-bag, at least 10 inches, full of earth,

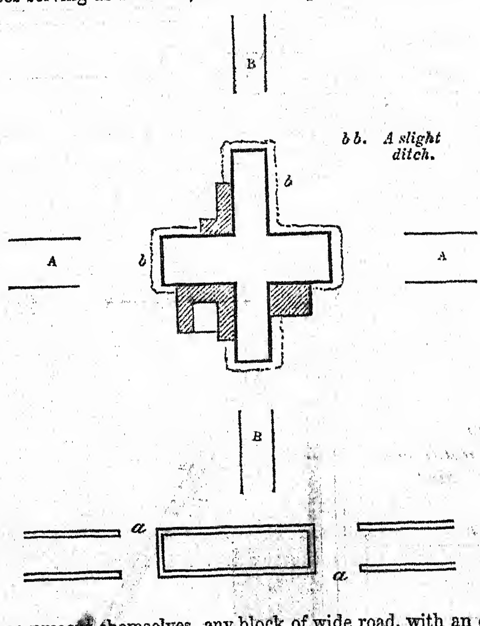
*12 inches thick,—		White pine,
* 9	do.	Yellow do.
* 4	do.	Oak, good.
2	do.	Oak, sheeted with $\frac{1}{8}$-inch wrought iron,†
$\frac{3}{8}$	do.	Sheet iron,

are the lowest that should be relied on as musket-proof.

BARRICADING ON THE OUTSKIRTS OF TOWNS.

As Insurgents are seldom burthened by artillery or baggage, they are not compelled to keep to the roads, where they would be most exposed; they will be apt to disperse over the fields: hence all hedges, or walls, parallel to the front of attack, or anything else that may give cover, should be removed.

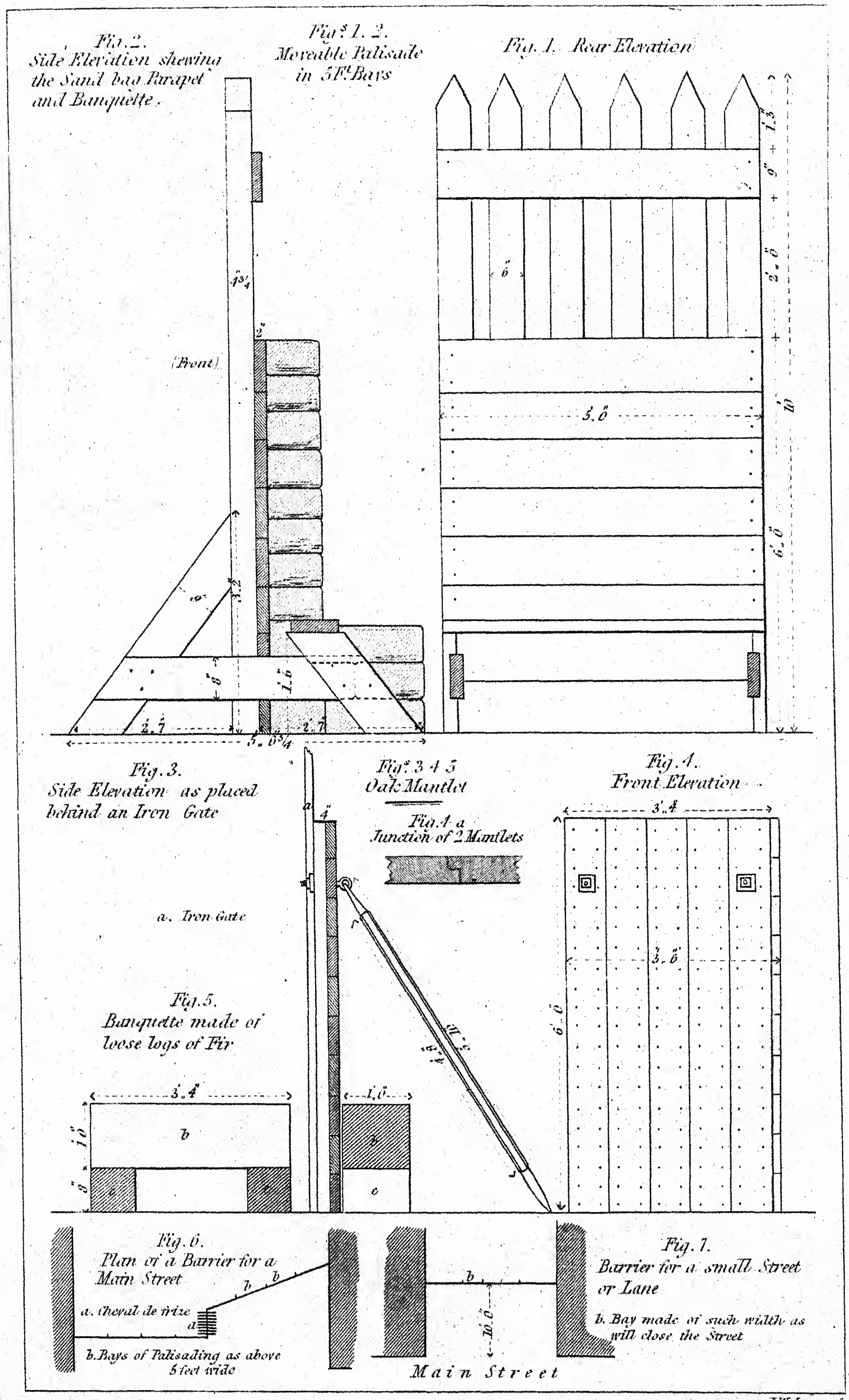
Where two tolerably wide roads, AA, BB, cross, they can generally be cut off so as to form a very fairly flanked redoubt, forbidding all advance along the roads themselves; the houses serving as barracks, and often capable of being loopholed.



If no crossings present themselves, any block of wide road, with an ordinary hedge,

* These thicknesses are best made up of different courses of plank crossing alternately, as in figs. 3, 4, 5, where the 4-inch oak is made up of two 2-inch planks.

† When oak is to be thus covered, a sheet of tarred brown paper should be placed between it and the metal, as the latter is likely to be corroded by the juices of the wood.



J.W. Lowry fc.

John Weale, 59, High Holborn 1845.

has only to be closed at the end or ends, by moving up the portions *a*, *a*, and a respectable 'Barrier' may still be obtained. This and the preceding are particularly suitable to the case where provision has to be made to front and rear.

Nearly all the expedients given for Barricades in the towns are more or less applicable to suburbs, and the immediately adjacent outskirts; but it is highly unadvisable, in most instances, to lose sight of the principle of concentration by this extended occupation. In addition to this list of expedients for towns, in the country, or in villages, &c., we have field gates, and often hurdles; both excellent in forming revetments and earthen parapets. R. J. N.

BARRIER—as distinct from 'Barricade,' and considered only in relation to Fortification.

The purpose regulates the construction. If the barrier is to be permanently defensible, it should be musket-proof, and then becomes a stockade.—See 'Stockade.'

If occasionally defensible, or else simply obstructive, palisading will suffice, with a sand-bag or other temporary parapet when required, behind and near enough to fire between the palisades.—See 'Palisade.'

The gates in both the above should if possible be of palisading; as the heavy stockade gate is unwieldly. If its being musket-proof is indispensable, 2-inch oak plank, covered with $\frac{1}{8}$-inch sheet iron, will be lighter and more effective,—*if* such materials can be procured.

Here the subject cannot be pursued farther without intrenching on 'Gate;' but as the higher class of field-works require such provision, the construction of a barrier gate is given in the Plate.

To regulate the width of the opening, 10 feet effective is assumed for waggons, carts, &c., of any size, as sufficient for a two-leaved gate. The one-leaved gate is given at 4 feet, as enough for a single horseman, or infantry two deep. A slight change must be made in fig. 1, if it is to be framed to admit of a wicket.

In the diagrams given, especially figs. 1, 2, the framing and scantling have been so regulated as to give abundant stability and strength to the whole, particularly the main posts *a*, without shewing the struts *c*, *d*, *f*, above ground, where they are not only in the way, but more likely to decay, especially where they enter the earth. If the level of the sleeper, *b*, admits of drainage, the whole should be laid and rammed tight with dry rubble, to allow the water to run freely off.

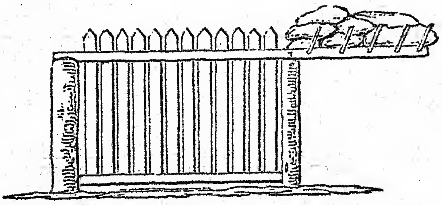
The gates themselves are so hung as to fall back clear of the opening; the hinges are kept entirely to the rear, and the upper ones are inverted. The heel-posts and meeting-stiles are allowed a sufficient thickness for the rails to enter without reduction as tenons: these rails are guarded by a strap of iron 2″ × $\frac{1}{4}$″ along the upper edge, to prevent their being readily cut through with an axe. The palisades are 6″ × 6″ scantling cut arris-wise, and 4″ apart: if much more, it would be possible for a thin person to work through.

The bar, *g*, is given as merely an ordinary security: if more be required, a strong chain and padlock, between two stout staples of $\frac{1}{2}$-inch iron, will answer all purposes conveniently.

Barrier gates should never be left unprotected.

When there is not time to construct such gates as are given in the Plate, the

following figure gives a tolerable substitute, and one that can be readily put together.



R. J. N.

BATTERY.—This article has been compiled partly from Notes by Lieut.-General Sir John Burgoyne, from some of the best authorities, and from reminiscences of the Compiler when in the Field.

Preliminary Remarks.—A Battery consists of two or more pieces of artillery united for the purpose of dispersing troops, or destroying that which covers and protects them. The term Battery also implies the emplacement * of artillery destined to act offensively or defensively. In the modern use of the word it likewise means the equipment of a certain number of pieces of ordnance, which has been previously explained in the article 'Artillery.' A battery may be open or covered.

A Covered Battery may be with or without embrasures; in the latter (en barbette) the height of the genouillère varies according to the description of gun carriage used.

	ft.	in.
For Field or Travelling Carriages it should be .	3	0
Garrison Carriages	2	3
Ship do.	1	6

or for Guns on Traversing Platforms, to fire over a parapet, 6 or 7 feet high.

Batteries, when with embrasures, have these openings cut or built in the parapet not less than 18 feet from centre to centre, except in Breaching Batteries; the mass between the embrasures forming a trapezium is called the Merlon. The thickness of the parapet towards the enemy depends upon the nature of the battery, as is explained in Section VIII., and in the article on the 'Penetration of Shot.'

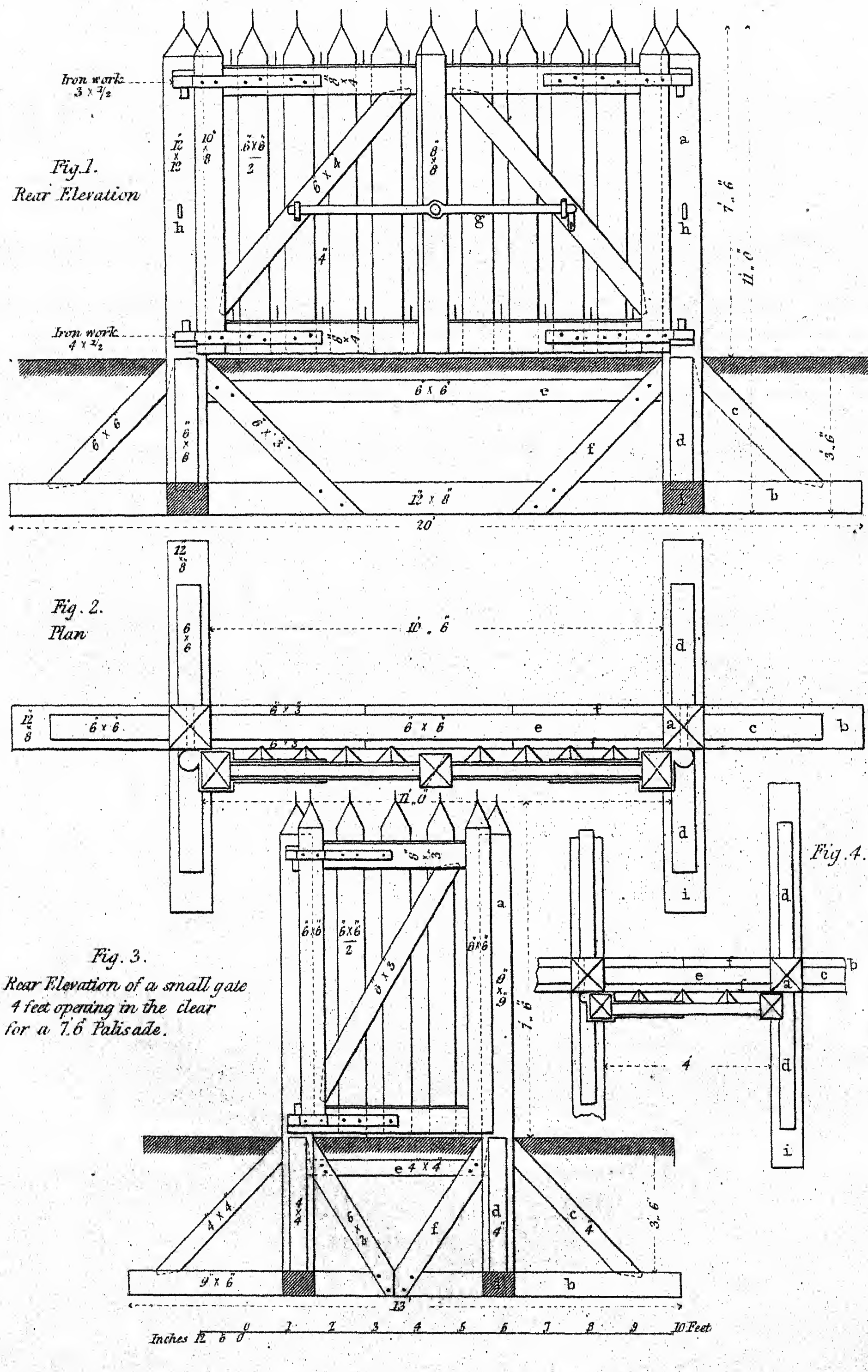
The artillery (which constitutes the battery—the parapets being merely the cover or protection from shot) requires substantial bearings either of solid ground for field pieces, or of timber, plank, or masonry platforms, for heavy artillery.

Batteries are divided into Siege and Field Batteries, as well as for the defence of coasts and that of places: the two last will be treated of in the article 'Defence.'

In the British Service, the construction of Batteries is an Engineer operation: this arrangement, different from that of most countries, probably arose from the nature of duties peculiar to our mode of warfare, generally confined to maritime expeditions and irregular attacks, where the construction of batteries and communications, and perhaps a parallel connecting them, constituted the principal works to be executed; and as the disembarkation of the ordnance, the park, laboratory duties, and placing the artillery in battery and working it, was sufficient to occupy that force, when celerity and the effect of a powerful fire was of the first importance. This arrangement it has been found convenient to continue; and the employment of Engineers and Sappers in the construction of Batteries permits an uninterrupted series of

* The emplacement of a Battery depends upon its object, whether for a momentary purpose in attack, or for the defence of a position, &c.

Rear Elevation of a Barrier Gate giving 10 ft. effective opening.... For 7'.6" Palisading.



R.J.N. del.

J.W. Lowry fc.

John Weale 59 High Holborn 1843.

operations, which the French Engineer Officers are inclined to think the best.—See Lieut.-General Sir Charles Pasley's 'Practical Operations of a Siege,' Article 221. Second edition.

SIEGE BATTERIES.

SECTION I.

DEFINITION.

These Batteries are either for guns, howitzers, or mortars, and have two objects, when employed in reducing a place.

First,—that of destroying the fire of the fort or fortress, as well as of ruining the parapets and military buildings, in order to approach, with as little risk as possible, to the place attacked; and,

Secondly,—when sufficiently near it, to effect a breach.

SECTION II.

BATTERIES FOR THE FIRST OBJECT, OR DESTRUCTION OF DEFENCES.

The early Batteries constructed in the First or Second Parallels, or from 30 to 50 yards from them, but sufficiently near to be protected by those parallels, are designated as Enfilade Batteries, Batteries in Reverse, en Écharpe, and Direct Batteries.

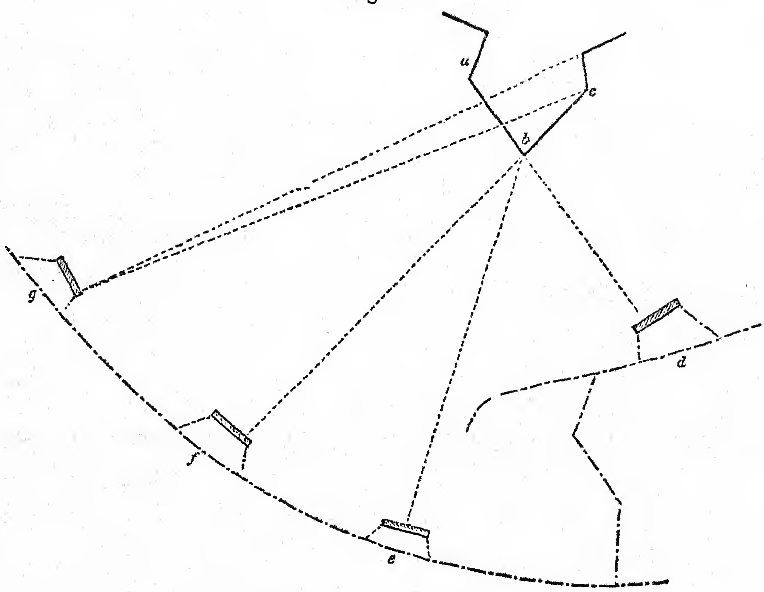
Those for Enfilade and Ricochet are established upon the prolongation of the face of a work, and perpendicular to that prolongation: if that position cannot be taken, from the unfavourable nature of localities, such as rivers, morasses, &c.,—then, by placing the Battery out of the prolongation, taking the interior of the face to be enfiladed obliquely, this will be a Reverse Battery: when the same circumstances occur on the other or exterior side, this will be a Battery en Écharpe: lastly, when the Battery is opposite and parallel to the face it should destroy, it is then termed a Direct Battery. The first of these four positions is the best, as its raking fire does much to clear the whole length of the line of its defenders and defences: the second has the same advantage, though to a modified extent.

The third and fourth are the least advisable, because it takes a considerably longer time to effect the object—the ruin of the parapets. Theoretically, the ricochet fire is the most efficacious, although in practice a difficult and nice operation, and only perfectly successful when long faces are open to enfilade.

The diagram subjoined will explain the position of the different Batteries which may be required to ruin the defences of a fortified place: *a*, *b*, *c*, representing the bastion attacked, *f* will be the Enfilade Battery, *g* that of the Reverse Battery, which subjects one face and flank of the bastion to reverse fire, and the adjoining curtain to enfilade fire; but the position of this battery is a dangerous one, being liable to be overlapped and easily destroyed by Sorties, by its contiguity to the place; it should only therefore be placed when a river or marsh intervenes.

The Battery en Écharpe may be necessary by the peculiarity of the ground, which prevents the parallel being extended as far as *f*; and the front of attack not reaching even as far as *e*, may render the Battery *d*, for direct fire, only available for the destruction of the defences of the bastion.

Diagram 1.



SECTION III.

BREACHING BATTERIES.

The position of Batteries to effect a practicable breach is contingent on the cover given to the Body of the Place attacked.

In sieges on paper they are generally placed on the crest of the glacis, but it may be at 50 or 500 yards, just as the walls are exposed; the emplacement of the near or distant Battery being a question of time and expediency: ten guns at the shorter distance will probably effect a breach, 100 feet wide, in 17 hours; and the greater in 74 hours: see article 'Breach.' But it may so occur that the escarp may be seen from a distant Battery, when it cannot from any intermediate point, except at the crest of the glacis; for instance, the guns of the Battery *f*, in the preceding diagram, may be able to breach the face *a*, *b*, of the bastion, by being on rising ground which slopes to the foot of the glacis: as regards time, therefore, it will be in favour of the distant Breaching Battery; the ulterior operations being confined to Sapping and Mining.

For the principles which generally regulate the *Emplacement* of Batteries, see article 'Attack,' by Lieut.-General Sir J. Burgoyne.

SECTION IV.

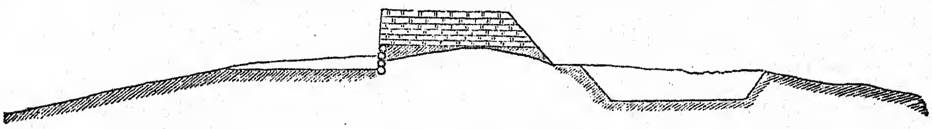
CONSTRUCTION OF BATTERIES FOR RUINING THE DEFENCES.

The construction of these may be as *Cavalier Batteries*, where the terreplein is raised above the level of the natural ground: *Sunken Batteries*, where the sole of the embrasure is on the general level of the ground: and *Half-sunken Batteries*, when the platform is about half the height of the genouillère below the level of the ground. These batteries are exceptions to the general rule of constructing them, and cannot be provided for by Tables, or suggestions for their execution, without complicated

statements of details, depending entirely upon local circumstances and the nature of the soil, which is well explained in Section XII., from Sir J. Burgoyne's Notes. Sometimes it is necessary to elevate a Battery to preserve it from an inundation, or to see an object which the artillery on the natural soil could not touch; and the ground sometimes requires a Sunken Battery to be constructed on the side of the hill sloping towards the place attacked.

The Batteries common at sieges, whether for guns, howitzers, or mortars, are *Elevated* and Half-sunken Batteries; the latter constructed, if possible, on the crest of rising ground, the slope falling from the place as explained in the diagram below: this position is most favourable, as the part to be revetted need not be below the excavation of the platform, and the position is very secure, particularly against shells lodging in the rear.

Diagram 2, of a Half-sunken Battery of 1 ft. 6 in. depth.



The Elevated Batteries, executed on the level of the natural soil, are simple in their construction; the Half-sunken being a modification of the Elevated, (see Plate I. figs. 1, 2,) which it is easy to provide for at the moment, by making the necessary deductions, according to the figure of the ground where the Half-sunken Battery may be placed.

SECTION V.

TRACE OF THE ELEVATED BATTERY FOR GUNS OR HOWITZERS ON THE NATURAL LEVEL OF THE SOIL.

The tracing of this Battery for the destruction of the defences, whether for ricochet or direct fire, is usually executed by the Senior Officer of Engineers of the Brigade to be employed. After the Director of the Trenches has decided in conjunction with him the exact position of the battery, he should lay out the line of fire during the day; and when dusk, trace out the battery in the following manner, taking care to be provided with a

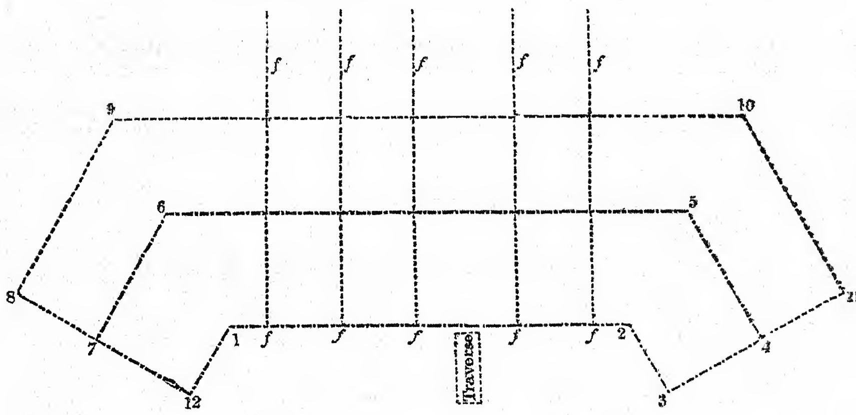
Hambro' line,
A square, or mason's level,
Two dozen pickets, 18 inches long,
Two long pickets, per piece, of 4 or 5 feet, to mark the embrasure,
A mallet,
Crow-bar to penetrate very hard ground,
And a 50-foot tape.

Each and all of these articles are necessary; and without them, difficulties will occur when it is dark.

Thus provided, the Engineer Officer will trace the foot of the parapet perpendicular to the line of fire previously laid, fixing one end of the Hambro' line upon a picket driven firmly in the ground at one extremity of the base of the interior slope of the parapet at the point marked 1, in diagram No. 3, and then stretched to the other extremity marked 2; thence to the end of the epaulement or shoulder, 3; from this, to the berm at 4, 5, 6, and 7, shewing the interior line of the ditch of the battery to be excavated; from 7 across to 8 (the width of the ditch at the shoulder), and again

to 9, 10, and 11, forming the exterior line to be excavated, to picket No. 4; there make fast, having previously taken one turn around each, keeping the Hambro' line as tight as possible, without drawing the pickets out of the ground: a short line is required to make good the trace of the battery not yet marked out from 1 to 12, and from 12 to 7.

Diagram 3.—Tracing of a Gun or Howitzer Battery for five pieces of Ordnance.



A reduced thickness may be allowed for the epaulement if it much exceeds such a length as given above.

When the tracing is completed, the line of fire (or centre of each embrasure) must be carefully marked by fixing the cross pickets at *f f* in the diagram, and with sufficient length out of the ground just above the genouillère, so that there should be no mistake when the cheeks of the embrasure are laid out and require to be constructed. When the tracing is completed, a Non-Commissioned Officer should be left in charge to prevent the pickets being disturbed, in the event of any time elapsing between the completion of the tracing and the arrival of the working party. The tracing of the magazine will be done next morning.—See Section xi.

Mortar Batteries constructed on the level of the ground will be executed precisely in the same manner, omitting the marking of the embrasures.

SECTION VI.

CONSTRUCTION OF BATTERIES FOR THE DESTRUCTION OF DEFENCES.

Previous to the tracing, the Senior Engineer of the Brigade will make his arrangements at the dépôt for his tools and materials, having them ready according to the Estimate provided in Table II., and the number of pieces of ordnance of which the battery is to consist; he will leave his Second Officer then to take down the working party towards dusk to the trenches with such articles as will be required in the first relief;—the second relief taking the remainder (or platforms and magazine framing) next morning: this will prevent much confusion.. It will be found convenient to divide the first party into three portions,—the excavators to be employed in the ditch,—those to be employed on the parapet,—and the revetters, and those to be employed on the communications to the rear,—and set the first portion to work as soon as it is sufficiently dark, by leading them from the trenches, between the tracing lines and

pickets,—4, 5, 6, 7, 8, 9, 10, and 11, of preceding diagram, forming the ditch to be excavated. To this party should be added a Sapper in the proportion of one to each gun, in order to instruct the men in their work: the whole party of excavators, each having a shovel and pick, will be arranged about 3 feet or the length of the shovel from the line of the berm, and 4 feet apart from each other: when thus placed they will break ground with the pickaxe, and when a sufficient quantity is loosened, the shovel will be used and the earth thrown over the berm line for the parapet.

As soon as the first portion or excavators are steadily at work, the second portion may be brought out from the trenches, one half placed on the berm to throw the earth forward, and the other half employed in adjusting it according to the line marked 12, 1, 2, and 3, for the parapets.

In a few minutes more the third portion or revetters and party for the communication may be set to work; and the first row of fascines (gabions, casks, or sand-bags, as may be afforded) will be laid, taking care to prepare a proper footing for the first course. The relative merits of revetting materials is discussed in Section VIII., and the quantity necessary is provided in Table II.; as before intimated, one Sapper *at least* per gun being attached to the revetters.

Assuming therefore that it is a Battery for five pieces of Ordnance, with one traverse and two shoulders, as described in diagram No. 3, and according to Table II., it will be seen that of the 132 men employed—

42 are in the ditch as excavators,
42 on the berm, and adjusting the parapet,
42 revetting and assisting, and forming the communication to the rear,
6 men on the traverse.

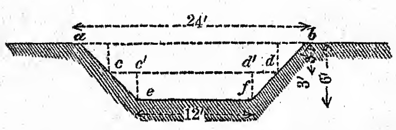
For this work they have 44 picks, 88 shovels, 22 rammers, 7 hand saws, 22 fascine mallets, 168 fascines (if revetted with fascines), 1176 pickets, and 45 gabions.

The first party thus employed ought to excavate to the depth of 3 feet in the eight hours, or 1 cubic yard per hour for each in that time.

Task-work is advocated by Sir J. Burgoyne in the article 'Attack;' that is, to give the men a fair job, and if they finish one or two hours before the relief comes, they should be allowed to return to their camp, without waiting for the completion of this term.

The most simple plan of arranging task-work, and adapted to the comprehension of the men, seems to be, by telling them that so soon as they excavate to the depth of the length of the shovel, between the Hambro' lines, they may go; and explaining to them that the breadth of the bottom part will be only 18 feet instead of 24, at the top: this they will easily understand.

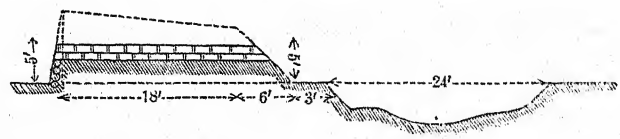
Diagram 4.—Section of Ditch of Battery, representing a double Task,



a, *b*, *c*, *d*, shewing the task of the first party; and *c*, *e*, *f*, *d*, that of the second, which will be about $\frac{5}{7}$ of the first; but they have a greater distance to throw the earth from the ditch.

Distribution of the Relief or Second Party for the Construction of the Battery.—Near the expiration of eight hours (the usual period given for a working party in the trenches), the relief, of the same strength as the first, will be brought down by an Engineer of the Brigade, who will have been sent to meet them, and conduct them to the spot. By this period the battery should be completed to the height of the genouillère, and part of the merlons to the height of 5 feet, as shewn in diagram No. 5, unless unusual difficulties have been encountered from the nature of the soil, and from the heavy fire of the place.

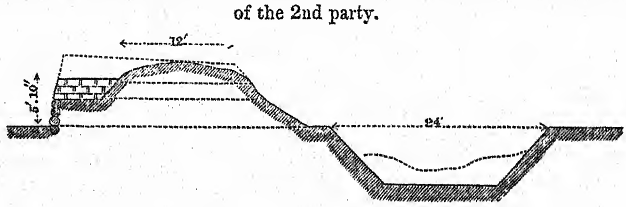
Diagram 5.—Shewing the state of the Battery at the termination of the work of the 1st party.



The arrangement of this relief will be as before, until daylight, when they should be changed, and the men removed from the parapet altogether, to prevent unnecessary casualties, as little is now gained by hastening the work, since the guns cannot open until daylight of the second morning; or in anticipating events in a regular siege, such as bringing in the guns and opening a partial fire, when the stores and ammunition are not collected in sufficient quantities.

It is therefore proposed, in cases where the artillery will not be required to open fire until the second morning, that the earth thrown on the berm and superior slope should be left there in a heap until next night, which will mask the battery and allow the interior to be continued without difficulty, as explained in diagram 6.

Diagram 6.—Shewing the state of the Battery at the termination of the work of the 2nd party.



Adverting to the change of the party, and the removal of the 42 men from the parapet and berm, they should at daylight be placed in improving the communications to the rear or parallel, as may be, and to the ditch of the battery; and the revetters may now revet the profile of the shoulders at the same time.

The communication or road from the battery to the rear or parallel is presumed to have been commenced at the same time as the battery, and Table No. II. provides for the men and tools for every 5 feet, the length of the tracing fascines: this removal from the parapet of 42 men is only to improve, give the necessary width, and render the arming of the battery easy and convenient.

The third party, which will arrive about 10 A.M. of the first morning, should bring down any remaining platforms and materials for the magazine; the execution of which is explained in Section IX., and the number of men and quantity of tools and materials given in Tables IV. to VIII.; taking care, in laying the platforms, that the

sleepers have good firm bearings, with a slope of $\frac{1}{2}$ an inch to the foot, and (transversely) laid on a perfectly dead level.

The last Engineer operation for the completion of the Battery will require a relief of about 72 men, to cut through the screen, which masked the work, for the embrasures, revetting them, and filling in the merlons: this should be commenced at dark of the second evening.

SECTION VII.

BREACHING AND COUNTER BATTERIES.

The construction of a Breaching Battery may either be effected as already explained in Section IV., and similar to all other batteries executed at a distance from the place attacked, when forming one of the early works of the siege;—

Or, by converting a lodgement into a Breaching Battery.

The first description being already disposed of,—

The conversion of the lodgement only has now to be explained. This operation is of two different kinds. *One* may be performed on the reduction of an outwork, from whence the escarp of the place can be breached,—the lodgement converted into a battery,—and the earth taken from the inside, instead of the ditch, as is usual in other batteries.

The *second*, the conversion of the crowning of the glacis into a Breaching or a Counter Battery by Sap.

First—The execution of a Breaching Battery, when a lodgement is secured in an outwork, is not difficult, although dangerous, inasmuch as the fire of the place can hardly be expected to be entirely overcome. The first operation will be giving a full thickness of 18 feet to the parapet, and revetting the interior slope; the revetting, for expedition, may have the lower part made of gabions or casks, which will serve to the height of the genouillère, and leave the merlons to be revetted after dark with fascines or sand-bags, when the embrasures are cut. The next work will be the widening the space for the platforms, and making the communication to the rear, as the earth must be taken from a considerable breadth, little depth having been previously obtained. Sand-bags and ballast baskets will come into requisition for clearing, filling the gabions, and giving sufficient bulk for the parapet of the battery.

This description of Breaching Battery will probably be commenced the morning after the lodgement is effected in the work (having reference more possibly to when the guns are required to open their fire), and as it will be done by daylight, the minimum number of men should be employed.—See Table III.

At mid-day the Battery, if commenced early in the morning, should be ready for laying the platforms, and for the construction of the magazine; it would be so if *given as a task* to the men.

The party for laying the platforms and magazine will be regulated by Tables IV. to VIII., and the work executed according to Sections VIII. IX., and before dark would be ready for the artillery.*

The last operation—of opening the embrasures and revetting the merlons—may be performed at some convenient opportunity during the night, when the battery is clear from other workmen, and the artillery of the place has perhaps slackened its fire. When the openings of the embrasures are cut, a sap roller should be rolled into the extreme opening. A few of the most skilful revetters should be employed, and fascines used in preference, as they stand longer, and would last, if well done, until the place is reduced. The merlons could be revetted with fascines, and filled in properly in 3 or 4 hours, if not under a very heavy fire.

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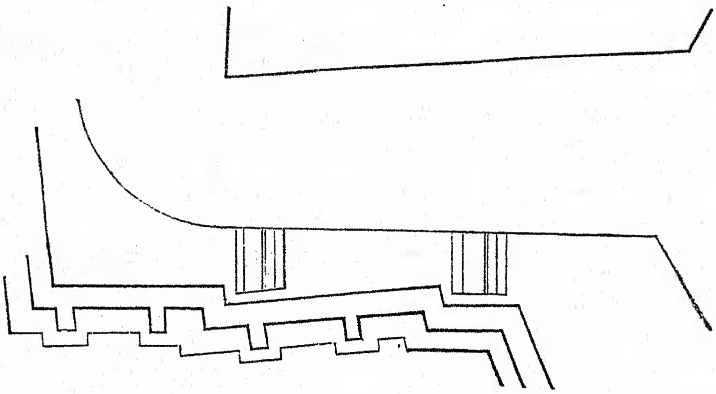
* The slope of the platform may be increased to one inch to a foot, and when travelling carriages are used, the part for the trail still more. See figs. 1 and 2, Plate III.—G. G. L.

The second description of Breaching Battery is that formed on the lodgement on the crest of the glacis; or it may be, for a Counter Battery, the difference being only in the solidity of the parapets. This requires a longer and a nicer operation, and should be executed by Sap, or rather enlarging the existing Sap, so as to give space and breadth for the Battery.

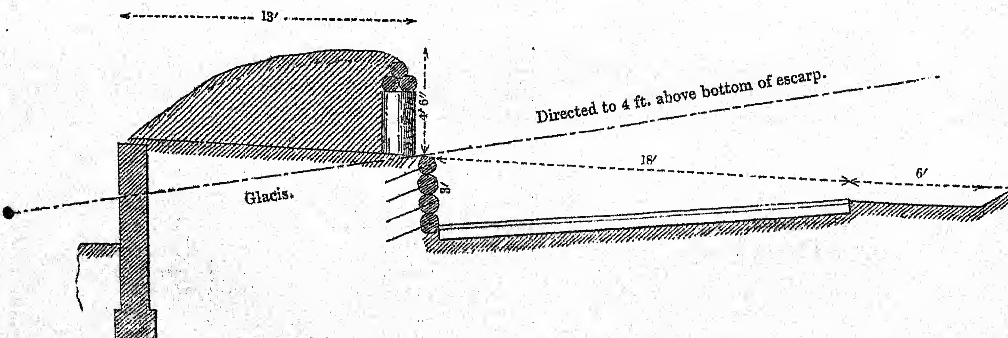
Diagram 7.—Shewing the Lodgement on the Crest of the Glacis.



As the Sapping advances—for the construction of the Battery may be considered to be by Sap, not in the ordinary way—the Sappers proceed to re-form the parapets as well as the traverses of the lodgement to the proper height, and give the latter sufficient length (24 feet) to cover the whole battery. When these are completed, the space for the magazines will be cut out, and the framing fixed and covered according to Section XI. and Table IV. This work, and the laying of the platforms, may be executed before night, so that the artillery may be brought in, and the ammunition stowed away before next morning.

The last Engineer operation to the Breaching or Counter Battery will be the opening of the embrasures and revetting them. At this period of the siege the fire of the place may be considered to be kept under, if not subdued; and to render this work as secure as possible, it is proposed to construct the embrasures in the same method and manner as before, by Sap.

Diagram 8.—Section of the Breaching Battery preparatory to the opening of the Embrasures.



The materials* necessary for embrasures being collected (according to Table III.) in the adjoining trenches—at some convenient period after dark the Sappers will commence the interior opening by clearing in front and cutting away as much of the parapet as will give space to plant a gabion on each side for the lining of the cheeks of the embrasure, as shewn in the following diagrams:

Diagram 9.—1st process.

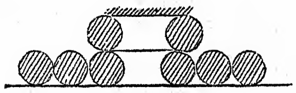


Diagram 10.—2nd process.

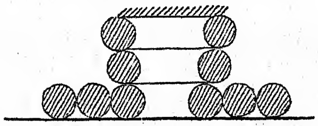


Diagram 11.—3rd process.

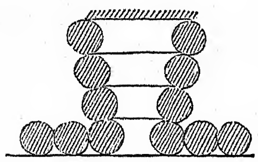
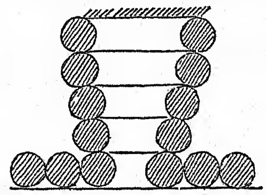


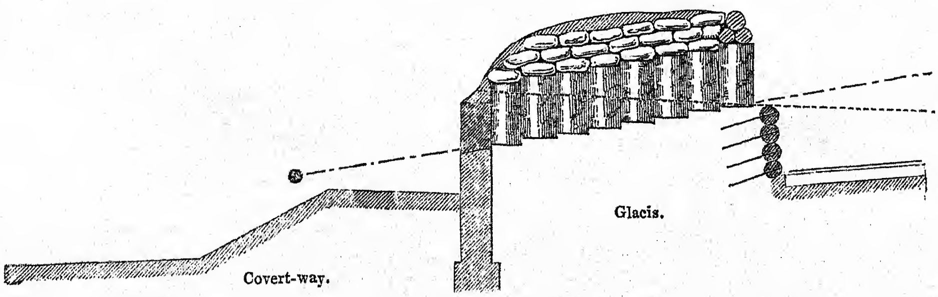
Diagram 12.—4th process.



The earth taken in front will serve to fill the gabion just fixed; but it should be remembered that every gabion will be required to be placed a few inches lower, in order to give the necessary slope to the sole of the embrasure; so that the work will advance step by step, each gabion fixed and filled from the earth in front, until within 2 feet of the crest of the covert-way. When the gabions are all planted, the completion of the lining of the embrasure upon the gabions will be with sand-bags, laid firmly, and with a slope: this method is selected to suit the irregularity of the position of the gabions, and likewise to expedite the work, the sand-bags having been previously filled and brought to the spot; and as they will not be immediately exposed to the explosion of the gun, they will in this case serve the purpose. Two rows of fascines will complete the interior height of the parapet, fixed on the gabions.

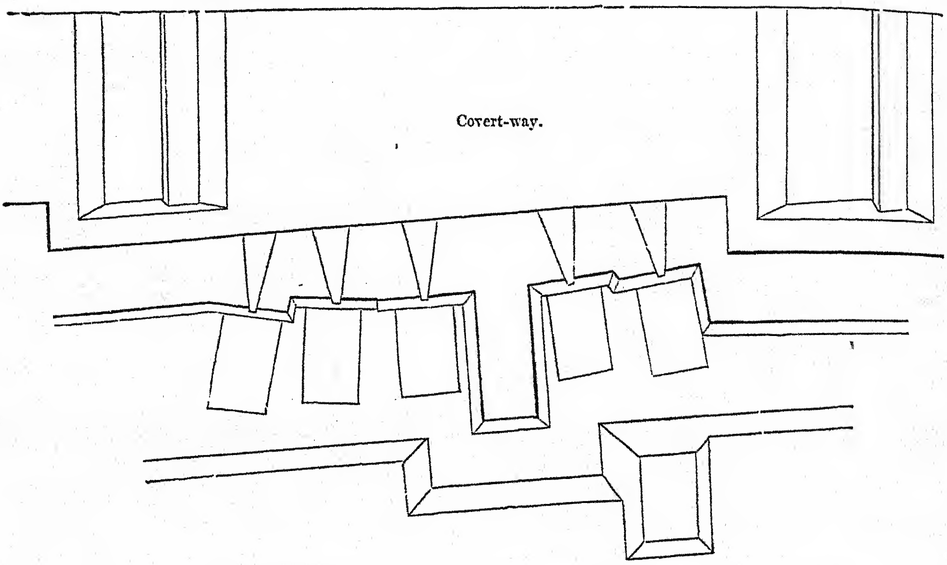
The following diagram explains the embrasure when completed:

Diagram 13.—Section of the Embrasure of a Breaching, or of a Counter Battery.



* In this particular operation, gabions are preferred.

Diagram 14.—Breaching Battery in the Crowning of the Covert-way.



It is conceived that this novel mode of constructing Breaching Batteries on the crest of the glacis will be found to be as successful as practicable: in any other mode of forming the embrasure, the opening of each must be cleared 4 feet at the interior, and 11 feet at the exterior: several men must be employed to execute that work and revet it afterwards; whilst in the method here proposed, only two are necessary, and they only partially exposed.

Before daylight, a Miner to each embrasure will be required to clear the remaining part unopened, and cut away a portion of the brickwork or masonry of the retaining wall of the crest of the covert-way, which, with a crow-bar, may be done in a few minutes.

When the work is completed, and the artillery run in, the embrasures should be furnished with mantlets, hung on the interior opening, to protect the artillerymen from musketry fire; they may be made of three 3-inch deals, or two 2-inch oak planks, spiked together as shewn in Plate II. fig. 6.

CONCLUDING REMARKS.

The following remarks upon Siege Batteries, arising out of some differences of opinion on minor points in the Construction and Position, &c., are offered by the Compiler.

First, he is inclined to believe that all working parties, after the completion of the first parallel, should have their arms; for this reason—if a Sortie, or the alarm of a Sortie, occurs, the workmen have no rallying point, and they, or the most of them, return to their camp; whilst if their arms are piled, or laid securely, not far in the rear, they will invariably stand to them, and receive orders how to act.

Secondly, respecting revetting materials, it appears that the relative advantages of fascines, gabions, casks, or sand-bags, consist more in their application than in the peculiar merit of one or the other; and each may be employed usefully in revetting batteries.

Lastly, the subject of Siege Batteries resolves itself into but two descriptions as regards the construction or labour,—those in which the parapets are taken from the ditch, and those formed from earth taken from the interior or terreplein of the battery. Any deviations are only modifications of these two.

There is one description of battery not adverted to, but which is one of the second class, *i.e.* the Siege Battery en crémaillère; this is constructed under peculiar circumstances by the conversion of an embankment of a canal, or dyke, on the bank of the opposite side of a river, into a Siege Battery, and the materials taken from the inside. G. G. L.

SECTION VIII.

REVETTING SIEGE BATTERIES, FROM NOTES* BY LIEUT.-GENERAL SIR J. F. BURGOYNE, G.C.B., R.E.

Batteries may be revetted with sand-bags, gabions, or fascines.

SAND-BAGS.

The sand-bag is a very favourite material for Batteries in our Service, but it does not last: such batteries not only require constant repairs all day, but the embrasures† must be rebuilt every night, to the great expenditure of sand-bags, and labour of Engineers and men. When, from want of time, or other causes, ground is to be broken immediately on the investment, and the batteries are to be commenced on the first or second night with a small besieging force, it is probable that Sand-bag Batteries *must* be employed with all their disadvantages: also, in distant batteries against small works, they may not perhaps cause much harm; but all this does not prevent their being the most inferior material for revetting. They do better for mortar batteries or traverses, and very well for magazines. In revetting with sand-bags, they should be laid headers and stretchers, with a slope of one-sixth at least.

GABIONS.

Neither are gabions good for revetting a battery, (beyond one row on the ground to the height of the genouillère, perhaps,) on account of the number of joints, except in the conversion of a lodgement into a Breaching Battery (see Section VII.), the time and trouble required to lay them to a proper slope, and the great difficulty of repairing them, especially in the embrasures, when out of order. They make very good traverses, and are required for masking embrasures. The dimensions for sap gabions need not be adhered to in those required for batteries.

FASCINES.

The best revetment is doubtless made of 18-feet fascines, 10 inches in diameter; each of these, being long and pliant, will bend to the settling of the earth; they are quickly and easily applied, present no joints to be loosened by explosion of ordnance, and, unless the fascines are very bad and loosely made, will not catch fire.‡ Those

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* For this and Section XII., written at Ciudad Rodrigo shortly after the siege of Burgos.

† After a few rounds, these embrasures become so damaged and open as to expose the gunners considerably, and frequently become choked by the stuff that falls down. It takes upwards of 800 sand-bags per gun at first starting only.

‡ A fascine battery (of long fascines) at Messina, made by the Neapolitan Artillery, for Instruction, and which had stood for five years, and had constant practice from it with heavy guns, was in perfect order. At the siege of Almeida, in 1810, the cheeks of the embrasures, of stone, sod, or tapia, were all injured by the explosion of their own heavy guns; some, however, that had been opened on the moment, and lined with fascines which had been in store a year, (and therefore not so good as when green,) stood perfectly, and did not burn.

6 or 8 feet in length have not the same advantage; being short, and consequently stiff, they are more likely to be forced out by the swelling of the earth, and their only superiority lies in their portability,—the materials, men and time, being identical in both.

With reference to fig. 1, Plate II., the number of 18-feet fascines for a 2-gun Battery will be

For interior lining	23
For cheeks of embrasures	20
Memorandum.—9 out of the 23 will be cut into short lengths, to break joint, &c.	
To which must be added, whatever may be the number of guns,	
For the two epaulements (if 18 ft. long)	18
Also, when traverses are used,	
For additional length, given by their breadth, to the parapet, per traverse	4
	65 *

The lower row is sunk about half its diameter in the ground, a trench being cut to receive it.

The first fascine is laid next to one end of the battery, and is picketed down, beginning from that end, all but the last picket: this end is let loose, to enable a Sapper sitting across it to hold it up, while three or four of the party, (according to its length,) standing across the second fascine, which they hold in both hands, all fronting the first, after two or three swings drive it well into the first; if not quite even, it must be taken out, and the process repeated, as any error in the first course will be felt throughout.

The other fascines are fixed in like manner.

The interior slope of the parapet is 2 feet, or about a quarter the height.

The pickets to be driven as shewn in fig. 5, Plate I., each *a, a*, passing through two fascines; and they are driven till their heads are buried in the upper one. An 18-feet fascine should have seven pickets, the knots of the gads (or withes) to be turned inside; and care must be taken not to drive the pickets into these last, as they are likely to be cut thereby. Pickets may be occasionally driven as *b, b*, independently of those as above marked *a, a*.

When batteries are near the place, much cover from musketry for the gunners is given by the fascines lining the embrasures being spread like a fan, *i. e.* vertical at the neck, and sloping at the regular slope of one-fourth at the other extremity. The interior ends are to be brought quite flush with the interior (fig. 1, Plate II.) slope of the parapet, as joints near the point of explosion are avoided; and less damage is done if a shot strikes these fascines, than when it disturbs those belonging to the interior of the battery, which by this plan are covered.

The slope given to the sole of the embrasure must depend on the relative level of the object fired at; if for enfilading, it may probably *rise* from the interior to the exterior.

The interior opening at the bottom of a gun embrasure is 22 inches wide; the exterior opening will be regulated by circumstances, but usually, half the thickness of the parapet as a direct embrasure.

In revetting Howitzer Batteries the neck must necessarily be wide, if mounted on a travelling carriage,—at least, 2 feet 6 inches,—from the shortness of the piece not

* This, with full allowance for waste, has been observed in Table II., 'Battery.'

allowing it to enter the embrasure when on its travelling carriage. In this case all that can be done is, to give the gunners what cover can be allowed consistently with the scope of the howitzer and by the use of the mantlets, if brought within musketry fire after the guns of the place have been silenced.

The same remark applies to carronades, which were used occasionally in the Peninsula.

REVETMENT OF MORTAR BATTERIES.

These, having no embrasures, require more earth in the parapet. The superior slope is reversed. They are revetted like other batteries when the materials are abundant; if not plentiful, and the batteries are not seen into from the place, then perhaps a half-revetting, as with a row of gabions: if the soil is stiff, it may be dispensed with; but if practicable, revetting is in every way more satisfactory.

The centres of the platforms to fire

$$\left.\begin{array}{l}\text{at } 45^\circ\\ \text{,, } 22^\circ\\ \text{,, } 15^\circ\end{array}\right\}\text{ should be }\left\{\begin{array}{l}12\text{ feet}\\ 31\text{ feet}\\ 48\text{ feet}\end{array}\right\}\text{ from the parapet, when near the place.}$$

$$\text{Thickness of parapets necessary against}\left\{\begin{array}{ll}\text{Heavy guns . . .} & \text{18 feet thick.}\\ \text{12 or 9-pounders .} & \text{12 or 14 feet.}\\ \text{6-pounders, \&c. .} & \text{8 feet.}\\ \text{Musketry . . .} & \text{4 feet.}\end{array}\right.$$

SECTION IX.

PLATFORMS.—COMMON OBLONG PATTERN.

To lay a Platform well, as used in the last war, the sleepers should lie in trenches, or, at least, as much of their front ends as is required to give them a slope of ½ inch to a foot; the intervals between must be completely and solidly filled in with stones, and brought up flush with earth. If earth alone be used, it must be very well rammed.

When three sleepers only can be allowed, as is sometimes done in Breaching Batteries, there must be one under each wheel, and one in the centre. The hurter is laid on and fixed to the sleepers. The planking is commonly all spiked down to the sleepers; but that mode is noisy, troublesome, and renders the removal and use of the materials again difficult.

It is best, especially when there are five sleepers, to confine the planking by ribands laid on it, and screwed* through it, at three or four points on each side, into the outside sleepers below. If the screws are well greased before insertion they will bear several removals: they should go through the sleepers, and may be fitted with nuts, which last must be uppermost.—See Plate III. figs. 3, 4.

Platforms with three sleepers laid parallel, and the planks only 12 feet long, are quite sufficient when the guns are not to traverse, which commonly is not requisite during a siege.

Where expedition is not necessary, it is important to have the sleepers well squared, and the planking of uniform thickness.

Mortar Platforms, usually 8 feet square, are laid as above; but in sandy soils the difficulty of giving stability to the platforms is entirely obviated by the use of a fascine, or junk foundation, in two crossed courses at right angles to each other.

The common oblong Siege Platform for guns on travelling carriages, 18′ × 12′, on

* As recommended also by Sir John Jones, in his 'Sieges,' and used in the last war; but since then Lieut.-Colonel Alderson, R.E., proposed a platform which has been found to answer thus far, and of which the subjoined account, p. 146, is written by that Officer.

five sleepers, even when laid with screws and ribands, instead of the planks being spiked down, weighs upwards of 26 cwt.—Plate III. figs. 3, 4.

J. F. B.

MADRAS PLATFORM.

The Madras Platform, used in the Indian Army, (Plate III. figs. 1, 2,) promises all the efficiency of the above without its disadvantages, weighing only 7 cwt. Attempts have been made to apply the same principle to Mortar Platforms, but hitherto unsuccessfully, as no reduction in weight has been effected in consequence of the great strength necessary for the different pieces. The common mortar platform, 8′ × 8′, on four sleepers, with the same scantling as that for gun platforms, requires wood more readily obtainable, and more convenient for transport. Both this last and the Madras mortar platform weigh about 8½ cwt.

In constructing the Madras platform care must be taken that the side pieces and transoms make one compact framing, the whole traversing on one front pivot, instead of on two or three, which has been proposed, and which limits the extent of traversing, from the side pieces approaching each other, like those of a parallel ruler, when moved.

All fastenings should be made with screws (instead of nails), which, if well greased when first driven, will admit of the whole being taken to pieces repeatedly. The trail piece, A, is steadied by cleats, and merely drops into its place; it will not be required when garrison carriages are used.

SIEGE GUN AND MORTAR PLATFORMS, INVENTED BY LIEUTENANT-COLONEL ALDERSON, R.E.

1. The object of the construction of the Siege Gun and Mortar Platforms is to place the artillery in battery on hard level surfaces, capable of retaining their position and of enabling the artillerymen to make correct practice with fewer men, from the facility afforded for running the gun or mortar up after each discharge.

2. As these works have generally to be laid under fire, and frequently during the night, the more simple their construction and the more uniform their parts the better.

3. The Gun Platform now to be described, and which has been satisfactorily proved by the Royal Artillery practice at Woolwich, has therefore been made to consist of baulks of uniform length and scantling, which serve for both sleepers and deck.

Each baulk is a piece of fir timber 9 feet long, 3½ inches thick, and 5 inches wide, and weighs about 37 lbs., sufficiently light to be carried to the spot by one man, besides his arms and ammunition, and being universal, it will fit into every part of the platform.

4. This is the *minimum* size; but if made on the spot or in the field, the principle may be equally adapted to any other increased dimensions, and thus render available such timber as may be found at the time with the greatest economy of materials and labour.

If constructed of the minimum dimensions above stated, a gun platform, 15 feet by 9, will consist of

	cwt.	qrs.	lbs.
46 baulks, with 47 trenails, (10 inches long and ¾ inch diameter, each of which makes 4 dowels, 2½ inches long,) 1 oak trenail being added for the rear centre pin of platform . .	15	0	22
9 round iron pins, 11 inches long, including the eye	0	0	18
10 iron shoes, and 20 inch screws	0	1	2
Total weight	15	2	14

Figs. 1 and 2, Plate IV., represent a baulk of the above-named dimensions, with eight holes bored 1¼ inch deep and ¾ inch diameter, at the distances specified, four on each of two opposite sides, both sides being alike when taken from opposite ends.

Oak dowels, 2½ inches long and ¾ inch diameter, (four of which are obtained from each trenail,) are then introduced half their length into the holes; on one side of each baulk (figs. 1 and 2,) *a*, *b*, *c*, *d*, represent the dowels, and *e*, *f*, *g*, *h*, the holes.

5. Into the end of the dowel which enters the baulk, a fox wedge (fig. 3) is introduced to prevent the dowel dropping out. The dowel is then 1¼ inch within the baulk, and projecting the same beyond it; this projection fits into the holes of the next baulk.

6. In order to lay a gun platform, take any ten of the baulks, and dowel them together two and two, as shewn at C, D, fig. 4; each two baulks will then form one sleeper, 15 feet in length.

7. It is to obtain this length that the holes are bored at the distances specified. Two iron shoes, 2 inches broad and ½ inch thick, are then fitted in, and fixed with a small screw, as shewn in figs. 4 and 5, to keep the sleepers steady.

8. Fig. 6 shews how the sleepers may be made 18 feet in length from the same baulk, should it be requisite, from the nature of the ground, to prevent the trail of the gun recoiling off the platform, which a 32-pounder invariably does with Service charge, when the platform is 15 feet in length, laid with the usual fall to front of ½ an inch per foot.

Each platform requires five sleepers, which must be laid in the space of 9 feet, the width of the intended platform, as shewn in fig. 4.

9. The platform is now laid in the usual manner, by excavating trenches to receive the sleepers, and, after levelling them with the field level, securing them in their places, by filling in the trench on both sides of the sleeper, and ramming it well, taking great care not to injure the sleeper.

10. Prior to commencing the laying the platform, holes ¾ inch in diameter must be bored 2½ inches, from one end of each sleeper, and that end is to be placed at the *front* of the platform.

11. Next take any one of the baulks, and lay it transversely on the ends of the five sleepers, over the holes thus bored, and bore five similar holes through the baulk immediately over them, as shewn in fig. 7.

12. Place five iron pins through these holes of the transverse baulk, and through the corresponding holes in the ends of the sleepers; the position of the sleepers in front will then be secured.

13. In the rear, a baulk must only be placed over the ends of the sleepers as a guide, but without boring either, since the *exact* place for the holes cannot be determined until the last baulk of the platform is laid, because it is not *necessary* that all the baulks should be of one width.

14. When the last baulk of the platform is laid, bore through it and the ends of the sleepers, as in front; insert the pins, and the platform is complete.

15. The centre *rear* pin is to be an oak trenail; it will then be flush with the platform, and let the trail of the gun recoil without meeting with any impediment.

16. The platform thus laid is a clear uninterrupted surface of 15′ × 9′, with the exception of the heads of the pins front and rear, a portion of which is shewn complete in fig. 4.

17. In the construction of this kind of platform, the holes in each baulk must be bored at precisely corresponding distances and heights, and this will be easily done by a dowel-box, fig. 8.

k, *k*, *k*, represent the bottom piece, for which the carpenter's bench, if long enough, may answer.

l, the end piece placed transversely.

m, *m*, the front piece through which the holes 1, 2, 3, 4, at the proper distances and height, are to be bored.

n, *n*, the rear piece or cleat.

o, *o*, *o*, *o*, four wedges to keep the baulk, P, close to the front piece.

One side of the baulk is then bored through the holes 1, 2, 3, 4, with a centre bit; the baulk is then cut off to the proper length by the gauge shewn by the saw kerf at *q*. The baulk is then taken out, turned over, and end for end being replaced and wedged up, the opposite side is bored as before.

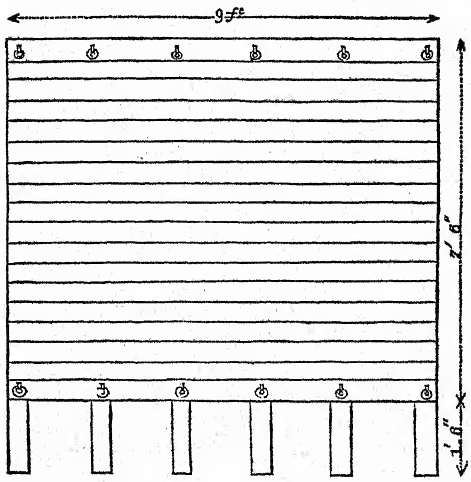
In this way each baulk will be similar in every respect.

18. Iron pins and shoes have been introduced in the construction of these platforms, to enable them to be easier *relaid* during the siege; but for all the purposes of strength the wooden pins or trenails will answer; and the shoes, excepting in bad ground, may be dispensed with, or made of wood, if required.

19. In taking to pieces a platform thus laid, the wooden pins or trenails must be driven or bored out, and fresh provided if the platform is required to be relaid.

MORTAR PLATFORMS.

Platform for 8-inch and 10-inch Mortars.



Siege Platforms for 8 and 10-inch mortars may also be constructed of baulks and pins of the same dimensions as those which have been described in the construction of Gun Platforms.

A mortar platform of this kind will consist of

	cwt.	qrs.	lbs.
24 baulks { 18 as deck, 6 as sleepers }	7	3	20
12 iron pins	0	0	24
Total . .	8	0	16

This will form a platform 9′ × 7′ 6″; the decking can be diminished, or increased to 9 feet square, as may be deemed necessary.

The ends of the sleepers will necessarily project in a platform of the above dimensions; should they be in the way, they can be cut off where the deck ceases; this will, however, prevent these sleepers from being used in any other description of platforms.

This platform has, like the gun platform, been satisfactorily proved by the Royal Artillery at Woolwich.

SECTION X.

TRAVERSES.

All Batteries of more than three pieces should have splinter-proof Traverses to protect the gunners from the effects of shells. One between every two guns is generally sufficient. They are made about 6 feet thick at base, and about 6 or 7 feet high. See fig. 5, Plate II.

A passage 2 feet wide is left, to enable the gunners to get out of the way when a shell falls in the battery, between the traverse and parapet. It should extend to the tail of the platforms.

If the battery is subject to be enfiladed, even by ricochet, as is very common on the crest of the glacis, the traverses must be at least 10 or 12 feet thick; and such being generally Sunken Batteries, as Breaching and Counter Batteries, the lower part of the traverse is left of the solid ground.

J. F. B.

SECTION XI.

MAGAZINES.

The Magazine recommended is that given in figs. 2, 3, 4, Plate II., as proposed by Lieut.-General Sir Chas. Pasley.

The lean-to principle is preferable to that in which the walls are carried up perpendicularly.

The baulks should be immediately covered with a tarpaulin, and every precaution taken as to drainage.

A magazine of these dimensions will stow at least 64 barrels; or enough for three 24-pounder guns for one day, at 240 rounds per day. There should be a separate magazine for every three or four guns, though in the same battery: 6 feet in length of magazine per gun is an ample allowance, at the above rate of consumption.

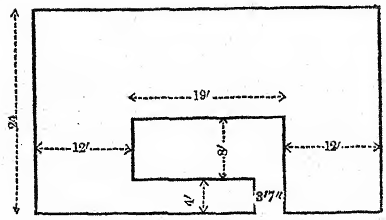
The entrance of the magazine should not be less than 20 or 25 yards in rear of the platforms. In 'Blindage,' Plate III. fig. 4, a section is given perfectly applicable to magazines.

J. F. B.

TRACING AND EXECUTION OF A TRIANGULAR FIELD MAGAZINE.

Abridged from Lieut.-General Sir Chas. Pasley's 'Practical Operations of a Siege,' 2nd edition. See Plate II.

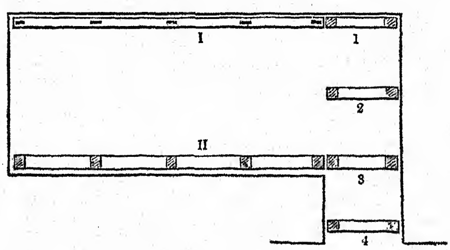
"This is represented in the annexed diagram, in which the body of the magazine, measuring 19 feet by 8, is supposed to have been laid out parallel to the face of the battery.



"In preparing to place the frame-work of the body of the magazine, the two sleepers for receiving the stanchions and struts were laid parallel to each other, at the clear distance of 6 feet 6 inches apart, in grooves properly prepared, the former being laid horizontally, and the latter at an angle of 45 degrees. These occupied about 15 feet of the length of the excavation of the body of the magazine, the rest of which belonged to the passage.

"When the two sleepers were laid, and the stanchions and struts were connected with each other, and fitted to their respective sleepers by pairs as soon as possible, and the stanchions were secured by wedges or otherwise, to keep them steady for the present, — the four passage frames were then placed, one in the direction of the stanchion sleeper produced; the other parallel to it, at the distance of about 11 feet to the rear, that is, a little in front of the alignment marked for the front of the rear trench: the other two were then set up at equidistant intervals between these two.

"This arrangement is represented in the annexed figure, in which the Roman numerals I. and II. represent the two sleepers, shewing the mortises or notches for the stanchions and struts of the frame-work of the body of the magazine, whilst the numeral figures 1, 2, 3, and 4, shew the positions of the passage frames.



"The sheeting planks were then introduced between the stanchions of the body of the magazine and the side of the vertical excavation adjacent, until the whole of the sunken part of the magazine was lined with woodwork on that side: after which the upper was revetted by about three courses of fascines; the sheeting and fascines together being so arranged as just to cover a space of about 6½ feet in height from the sole of the excavation upwards. The splinter-proof timbers were then laid, in the intervals between the triangular frames of the body of the magazine, with the foot of each resting on the strut sleeper, and the top of each lying against the uppermost course of fascines. At the same time, the extreme end and the two sides of the passage were lined with sheeting planks, excepting of course that part of one side which was left open to communicate with the body of the magazine. The whole passage, including the extreme end of the body, was there covered by splinter-proof timbers laid horizontally over all the caps, which being done, the timbers were to be covered by tarpaulins.

"In placing the sheeting, fascines, and timbers, the whole of the men were required to hand those materials which had previously been laid near the spot. As soon as the above were disposed of, the labourers' work again proceeded until the magazine was finished. About three, and not exceeding four, men were employed as rammers, the remainder as diggers and shovellers. In consequence of its being impossible to dispose of all the first excavated portions of earth properly, until the magazine was covered in, as many men as possible were employed as shovellers, by whom the loose earth, especially that in rear of the magazine, was thrown upon the parapet, until it attained the dimensions specified."

For dimensions of the magazine see Plate II. figs. 2, 3, 4.

SECTION XII.

REMARKS ON SIEGE BATTERIES, FROM NOTES OF LIEUT.-GENERAL SIR J. F. BURGOYNE, G.C.B., R.E.

The most difficult operation of a Siege is the execution of Siege Batteries, and requires the best Officers to be employed.

It is here that regularity and system are most particularly necessary to arrange the men and stores in such manner that there may be no delay and confusion.

The quickest mode of making a battery (though but of rare occurrence) is by raising the parapet entirely of materials brought from a short distance in baskets; or with wool-packs and sacks of earth, &c., thrown in. In this way, the revetting, and laying platforms, can be commenced at once; but the mode is only applicable to a small quantity of work, such as a single battery for a few guns; and even then, the working party must be very strong, the arrangements good, the baskets numerous, and the supply of earth near at hand and abundant.

The next quickest is the Half-sunken Battery, in which the earth is got partly out of the interior (excavated to about 18 inches deep), and partly from the ditch. This may be expeditiously done, the stuff for the parapet being sooner obtained. The most usual mode, however, is to raise the battery entirely above ground by excavating from the ditch.

The longest and most inconvenient method is that of the Full-sunken Battery, where the interior is sunk to the depth of the genouillère, unless the ground, by falling immediately from the back of the parapet, prevents the excavation being so very great before the platforms can be laid, as it must be in level ground. In executing this sort of battery, care must be taken that the natural ground does not interfere with the fire of the guns, and a very slight swell will do this.*

Plate I. fig. 4. If the Battery is on the side of a hill sloping towards the place, the work in the interior will become excessive; as happened at the siege of Ciudad Rodrigo, where, at the tail of the platform, the depth to be excavated was 6 or 7 feet.

ELEVATED BATTERY: BUILT ON THE NATURAL SURFACE OF THE GROUND.

The best, the ordinary, and safest mode — that of excavating the whole from the ditch—may be done thus:

The foot of the interior slope of the parapet (which is the regulating line in all instances) is first accurately laid out; then a parallel line, at the distance of 29 feet, gives the interior edge of the ditch, Plate I. fig. 1.

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* Lieut.-General Sir Chas. Pasley very judiciously recommends, in determining the position of a Gun Battery for direct firing, that in tracing a battery the person should kneel or lie down, looking towards the fortress, in order to guard against the inequalities of ground, and to be certain that the guns can hit the object.

The workmen to be placed along the ditch on the line *a*, 4 feet apart, or 5 men per gun.

The depth of the ditch to be 6 feet, to obtain the earth for the parapet, and the task, (if that system be adopted, and particularly if they have a double set,) which may well be 4 feet wide and 6 feet deep, should be complete in 24 hours. But as that would bring it to a finish at night (batteries being nearly always commenced at dusk), the additional hours to next morning will afford ample time.

A party of 3 men per gun to be on the berm to throw forward the earth for the parapet, and give a good backing to the interior revetment; they must keep the berm *perfectly clear* all night: this is a point of great consequence, and most particularly to be attended to, because these men, being more exposed, are more liable to shrink from their work. At morning, the whole of the earth should be close to the interior revetment, and not a particle of it on the berm, which can only be done by keeping the men at this work from the first, and not putting it off till the morning: they should also have a relief, or double set; or, in other words, the working party should all take their turn in this dangerous duty.

Three men per gun will also be necessary for ramming the earth well, particularly near the interior of the parapet: this also is a point of great consequence, and very apt to be much neglected; the earth settles exceedingly from the concussion of the firing; so much so, that the merlon will sometimes be seen almost entirely settled down, and leaving the revetting of long fascines standing nearly by itself. In Sand-bag Batteries (where those flimsy materials—sand-bags—are soon demolished), the embrasures choke, and the merlons settle so that the crest of the parapet is soon reduced to a waving line, at most not more than 5 feet above the ground.

At one end of the battery, a narrow ramp must be made to communicate with the ditch, and enable the reliefs to pass under cover.

The attention of the Officers will be much required,

1st. To the men in the ditch, that they work hard, and do not cut away from the escarp, which they are apt to do.

2nd. To the men on the berm, and rammers, that they remain steady at their post and work.

With these, and the bringing up the various stores *in time*,—revetting the battery,—laying platforms,—and making magazines, Battery duty becomes a most arduous undertaking, and one that requires nice management to be completed with expedition.

The French mode of excavating the ditch in the shortest time is by a second row of workmen, 6 feet from the first, not covering but chequered with them: thus, instead of placing one row of men 3 feet apart, which would be crowded, each alternate man is moved out in another line 6 feet from the first; then, the whole working in one direction from the battery, there will be room for the second row to throw the earth through the intervals of the first. But independently of the difficulty (which they acknowledge) of carrying this into execution in the night, and perhaps under fire, the excavations will be inconvenient to work in on the following day. Hence a single row, 4 feet apart, is preferable.

HALF-SUNKEN BATTERY.

Plate I. fig. 2. In the execution of these, a row of men, 4 feet apart, will be wanted for the excavation of the interior of the battery, which may be about 18 inches deep. These men will be occasionally interrupted as the revetting goes on, but not seriously so. The first row of fascines may be laid before the excavation is commenced, it being understood that the fascines of the excavated part are to supersede the hurter of the platform.

The guns must be all ready, with a good access made to the battery, that they may

be run in during the last hour or two of dark, when they will lie against the merlons till the platforms are laid.

FULL-SUNKEN BATTERY.

Plate I. fig. 3. It would appear, at first sight, in these, that having nothing to raise but the merlons, the work would be much diminished; but the sinking of the whole interior to a depth of 3 feet, with a sufficient passage to the rear, leads to greater labour than that of raising the parapet entirely from the ground, since a Sunken Battery must have a width of about 30 feet, not to be very crowded and inconvenient.* The earth that will about complete such a battery will be had at the depth of 2 feet 6 inches, or 3 feet, by which we gain that height of solid parapet formed of the natural ground, and a somewhat speedier cover for the men; but the inconveniences are so great, on service, that it cannot be approved of, or considered even the quickest way, for the following reasons:

1st. The men will cut the 1st trench to the depth of 3 feet to gain cover, 6 inches of which must be afterwards filled in again.

2nd. As the excavation enlarges, the distance to throw the earth becomes great, and indeed requires an additional row of men.

3rd. No platforms can be laid, nor traverses made, nor the revetment carried on, nor even materials brought in, until the excavation of much of the interior space near the parapet is finished: hence not nearly so many men can be employed at the same time as in a battery entirely raised from the ground, and the materials taken from the ditch, where all things may go on together.

4th. When a parallel is to be converted into such a battery,—the most common case in which it occurs,—the parapet must be made up solid, and the embrasures cleared out afterwards:† in this, the excavation becomes considerable, which may be easily conceived by adding to the bulk of the embrasure (as finished) that at the cheeks which must be removed to obtain a foundation for the lining; and remembering that the newly thrown up earth is so loose, even when rammed, as to require a great slope to stand whilst the revetting goes on: the consequence is, that in the impatience to open them, which appears at first but a trifling operation, they are almost invariably badly done,—in irregular directions,—and the mouth of the embrasure never so open or so low as it ought to be.

5th. The foundation will be so uneven that the laying of the platforms becomes tedious, and is very frequently ill done.

6th. The interior of the battery is difficult to drain, always confined, and shells are caught by the reverse slope of the excavation.

7th. Magazines, being on the level of the natural ground, are not so well covered by the parapet.

The principal case where this mode may be advantageous, and time gained, is where a parallel has been made, and part of it is to be converted into a battery, instead of commencing a fresh one in front: in this instance a considerable part of the work is already executed, and may be continued during the day, whilst a new communication is being made round its rear;—it is thus that the battery may be said to be quickly executed, counting from the time of commencing its conversion to a new purpose.

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* When the fire of the place is still able to plunge into the battery, even this may not be allowed, as the rear becomes so much exposed.

† An evident loss of time, and an inconvenient practice: it can only be of service when the battery is to be thrown up some time before it is opened, and the position rendered imperative by circumstances.

These remarks suppose the natural ground to be level and perfectly open in front, without any impediment to the fire: if it falls greatly to the rear, there is a great advantage in sinking the interior. On the crest of the glacis there are many reasons that make it necessary. (Plate I. fig. 6.) If the ground rises to the rear, excavation is unavoidable, but the labour is enormous.—See Plate I. fig. 4.

As in Full-sunken Batteries the natural ground forms the sole of the embrasure, it cannot (when level, or rising towards the place) be cut away to admit of guns being depressed, as required in Breaching and Counter Batteries, where the platforms may even have to be raised. When this necessity for depression can be foreseen, care must be taken to leave the bottom of the trench higher than at other points. It is always easy to reduce, not so to replace.

Note.—The preceding details refer to Batteries perpendicular to their line of fire, or nearly so. It seldom happens that they are required with such an obliquity as to render a Crémaillère Battery necessary, except on dykes and banks of rivers. At Salamanca, one instance occurred during the late war; but there it was cut out of a heap or bank of ruins,—thus greatly simplifying the operation, which, when this description of battery is built and revetted from the ground, becomes extremely troublesome. It has however one advantage, that traverses are not so necessary.

SECTION XIII.

POSITION AND CONSTRUCTION OF FIELD BATTERIES.

The position of Batteries ought always to be on the most commanding and most advanced points, in order to discover the country to the greatest possible distance, and to produce a cross fire on that space which the enemy would have to march over in attacking the position.

If there be in front any road or passage which the enemy would be obliged to follow, or any grove of trees which there is not time to fell, or any kind of cover whatever which cannot be removed for want of time and means,—we must begin by marking the place for a certain number of pieces to bear on these objects in proportion to the whole number of which the battery is to be composed, not forgetting those which are necessary to produce a cross fire corresponding with the other batteries.

However, in the uncertainty in which we must be with respect to the manner in which the enemy may form his attack, and how he may dispose his line or columns, it is always advisable to mark some embrasures more than there are guns in the battery.

It does not always happen that the position commands all parts of the country in front and on the flanks,—on the contrary, frequently, whether on the front or flanks, the position may be on the edge of a valley intersected by a river or rivulet, the passage which it is necessary to defend; and the opposite banks are of the same height, and not more than 800 or 900 paces distant. In this case, in advancing on the salient points, the first attention is to preserve, at least, equality of height with the opposite bank. But if the slope in front be not regularly formed en glacis, but uneven or forming a double slope, the consequence is, that from our position we cannot discover all the ground in front;—it will be necessary to take down the guns to that part of the slope that sees the whole of the valley. As this will be commanded by the opposite ground, and there is little time to cover the guns sufficiently, we must erect also a battery in its rear for our heaviest guns to bear on the opposite spot most favourable to the enemy, preserving an equal height, or greater, if possible.

Having established the principal battery, it is then necessary to take into consideration the principal debouches of which the enemy might make use; namely, the

great roads, bridges which cannot be destroyed, or for some reason are preserved, and the places where he is most likely to cross either by fording or pontoons.

When the ground of the position is not en glacis, and from the summit we cannot defend the slope in its whole length to the bottom of the valley, irregularities of the ground must be taken advantage of to obtain a cross flanking fire. But it is indispensable that the battery be covered by traverses from the fire of the opposite ground, avoiding at the same time being commanded within grape.

The use of traverses being only applicable to works intended to *flank* the bottom of the hill, it may be necessary to dispute the passages by a direct fire from a battery half-way down the hill: this can only be done by raising parapets to a sufficient height to cover the carriage in its whole length, so that it can only be seen through the embrasure, which need not be very large, as it is intended to bear on only one passage.—(See Profile No. 1, Field Battery.)

The most expeditious method to form these batteries is to take the level of the ground for the sole of the embrasure.—(See Profile No. 2.)

The Artillery thus placed in advance will *retire*, after having defended these approaches, through the intervals of the line of position.

If the irregularities in front of the position are not very considerable, instead of advancing down the hill, it will sometimes be sufficient to raise the guns 2 or 3 feet (see Profile No. 3), to discover the whole of the slope and see the enemy everywhere. This will be preferable, particularly when we cannot so advance without subjecting ourselves to command from the opposite heights, which occasions great labour in forming traverses and sinking trenches, to remedy the evil of being commanded at a small distance.

*Construction.—Profile.**

The Thickness of parapets against musketry need be only 3 or 4 feet.

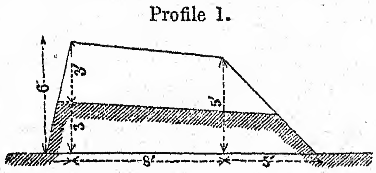
To resist cannon at a distance of 1200 paces, 9 feet will be sufficient; and in all cases, and at the nearest distances, 12 feet will resist the nearest artillery used in the field.

The Height of the parapet above the platform in front of the gun cannot exceed 3 feet, but in the space between it is raised to 4 feet 4 inches;—this relates to ground not commanded.—(See Profile No. 4.)

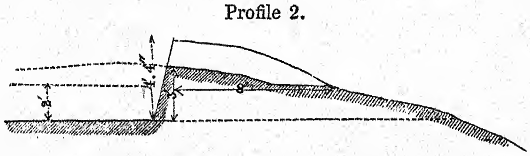
When commanded, the parapet must be raised, or traverses formed, as circumstances may require.

The four following profiles are of the description required in the field for Batteries.

Profile 1.

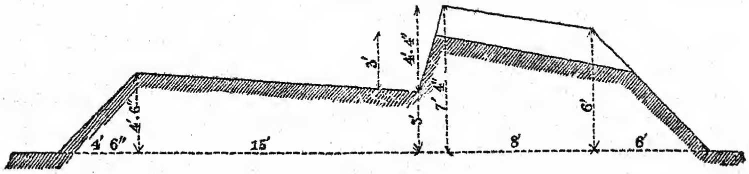


Profile 2.

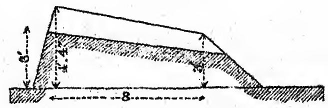


* See 'Genouillère.'

Profile 3.



Profile 4.



BATTERY TABLES.

In the following Tables no difference is made with reference to labour, tools, and materials in the description of Battery, whether Elevated, Sunk, or Half-sunk; one sufficient allowance being made for all in any soil except hard gravel or rock: 20 feet length of parapet per gun, or 23 feet per mortar, is allowed for each piece, and is taken, with its labour, tools, and materials, as the unit. A like quantity is assumed for each epaulement, and one-third for each traverse, on account of additional labour, &c., in the extra length of parapet it entails, as well as in its own construction: in Breaching and Counter Batteries ⅔rds per traverse is given.

The gun and mortar are placed on the same footing, as the work in the 3 extra feet in the latter may be set against that in the embrasure of the former. Full allowance is made for waste in fascines and sand-bags: the apparently excessive demand for the latter is, however, the result of much experience in the field.

In Gabion Batteries, a full revetment of gabions has been omitted as objectionable; but as there are cases when enough may be obtained for one row on the ground, and the rest completed with fascines or sand-bags, provision has been made for this in Table II.

BATTERY TABLE I.

DIMENSIONS FOR SIEGE BATTERIES.

	ft.	in.		ft.	in.
Thickness of parapet at top .	18	0	Slope of platform . per foot	0	0½
Height of parapet* . . .	7	6	Interior slope of parapet,—from ¼th to ⅓rd height	”	
Distance of embrasures from centre to centre . . .	20	0	Superior slope . . per foot	0	1
Interior opening of embrasure	2	0	Ditto mortar batteries, when reversed . . per foot	0	1
Exterior ditto (= ½ thickness of parapet) . . .	9	0	Exterior ditto mortar batteries, if not revetted, per ft.	1	0
Height of genouillère, for travelling carriage . .	3	0			
Height of genouillère, for garrison carriage . .	2	3	Distance of traverse from parapet	2	0
Width of berm	3	0	Length of traverse = that of platform	”	
Depth of ditch	6	0			
Width of ditto at top . . .	24	0	Breadth of traverse at base .	7	0
Ditto ditto at bottom .	12	0	Ditto ditto at top .	4	0
Platform for travelling carriage					
Length	18	0	Length of epaulement,—sufficient to protect the rear of the battery . .	”	
Breadth	12	0			
Ditto for garrison carriage					
Length	15	0	Mortar platforms, from centre to centre	23	0
Breadth	12	0			

* In Half-sunken Batteries, 5 ft. 6 in. or 6 ft. In Sunken Batteries, 5 ft.

BATTERY TABLE II.

CONSTRUCTION OF BATTERIES FOR THE DESTRUCTION OF THE DEFENCES.

	Labour, Tools, and Materials for Parapet, Epaulements, and Traverses; not including Platforms or Magazines.	Ratio per Gun or Mortar, as the Unit.	2 Guns and 2 Epaulements.	3 Guns and 2 Epaulements.	4 Guns, 2 Epaulements, and 1 Traverse.	6 Guns, 2 Epaulements, and 2 Traverses.
		Unit.	Unit × 4.	Unit × 5.	Unit × $6\frac{1}{3}$.	Unit × $8\frac{2}{3}$.
	FASCINE BATTERIES.					
Labour.	Sappers, or Acting ditto; Revetters . . .	3	12	15	19	26
Labour.	Line; Diggers, Shovellers, Rammers, and Assisting Revetters	15	60	75	95	130
Labour.	Total labour . .	18	72	90	114	156
Tools.	Pickaxes	6	24	30	38	52
Tools.	Shovels	12	48	60	76	104
Tools.	Rammers	3	12	15	19	26
Tools.	Hand saws	1	4	5	6	8
Tools.	Fascine mallets	3	12	15	19	26
Tools.	Tracing pickets for embrasures, 4 feet long .	2	4	6	8	12
Tools.	Small ditto (per Battery)	20	,,	,,	,,	,,
Tools.	Crow-bar (per Battery)	1	,,	,,	,,	,,
Tools.	50-feet tape (per Battery)	1	,,	,,	,,	,,
Tools.	Field level (per Battery)	1	,,	,,	,,	,,
Materials.	Fascines, 18′ × 10″ diam^{r}. Revetting parapet and embrasures	24	96	120	152	208
Materials.	Fascines, 18′ × 10″ diam^{r}. Revetting end of each epaulement	(12)	24	24	24	24
Materials.	Pickets for ditto, 4 feet long	168	840	1008	1232	1624
Materials.	Gabions for traverses, 3 ft. high × 2 ft. diameter	,,	,,	,,	48	96
	SAND-BAG BATTERIES.					
Labour.	Sappers, or Acting ditto; Revetters . . .	3	12	15	19	26
Labour.	Line; Diggers, Shovellers, Rammers, and Fillers	18	72	90	114	156
Labour.	Total labour . .	21	84	105	133	182
Tools.	Pickaxes	6	24	30	38	52
Tools.	Shovels	15	60	75	95	130
Tools.	Rammers	3	12	15	19	26
Tools.	Hand mallets	6	24	30	38	52
Tools.	Tracing pickets for embrasures, 4 feet long .	2	4	6	8	12
Tools.	Small ditto (per Battery)	20	,,	,,	,,	,,
Tools.	Crow-bar (per Battery)	1	,,	,,	,,	,,
Tools.	50-feet tape (per Battery)	1	,,	,,	,,	,,
Tools.	Field level (per Battery)	1	,,	,,	,,	,,
Materials.	Sand-bags, 1-bushel. Revetting parapet and embrasures	800	3200	4000	5067	6934
Materials.	Sand-bags, 1-bushel. Revetting end of each epaulement	(300)	600	600	600	600
Materials.	Gabions, 3′ × 2′ diameter	,,	,,	,,	48	96
Materials.	(Sand-bags for traverses, if gabions cannot be had)	,,	,,	,,	600	1200
	GABION* BATTERIES.—UPPER HALF FASCINE. Labour and Tools.—See 'Fascine Batteries.'					
Materials.	Gabions, 3′ × 2′ diameter	12	48	60	124†	200†
Materials.	Fascines, 18′ × 10″. Revetting parapet and embrasures . .	17	68	85	108	148
Materials.	Fascines, 18′ × 10″. Revetting end of each epaulement . .	(12)	24	24	24	24
Materials.	Pickets, 4 feet long	119	644‡	763‡	924‡	1024‡
	UPPER HALF SAND-BAG. Labour and Tools.—See 'Sand-bag Batteries.'					
Materials.	Gabions, 3′ × 2′ diameter	12	48	60	76	104
Materials.	Sand-bags, 1-bushel. Revetting parapet and embrasures	600	2400	3000	4400†	6400†
Materials.	Sand-bags, 1-bushel. Revetting end of each epaulement	(300)	600	600	600	600

* Or cask. Beef and pork tierces, or rum hogsheads, give dimensions nearest to those of the gabions.
† Including for traverses. ‡ Including for the ends of the epaulements.

N.B.—For Communications with the Parallel,—add per 5 ft. in length, 1 labourer, 1 tracing fascine, 1 pickaxe, 1 shovel.

BATTERY TABLE III.

CONSTRUCTION OF BREACHING AND COUNTER BATTERIES.

	Labour, Tools, and Materials, for Parapet and Traverses; not including Platforms or Magazines.	Ratio per Gun, as the Unit.	2 Guns.	3 Guns.	4 Guns and 1 Traverse.	6 Guns and 2 Traverses.
		Unit.	Unit × 2.	Unit × 3.	Unit × $4\frac{2}{3}$.*	Unit × $7\frac{1}{3}$.*
Labour.	Sappers, or Acting ditto	6	12	18	28	44
	Line; as Labourers, according to localities	”	”	”	”	”
	Total labour	6	12	18	28	44
Tools.	Pickaxes	6	12	18	28	44
	Shovels	6	12	18	28	44
	Crow-bars	1	2	3	4	6
	Hand saws	1	2	3	4	6
	Fascine mallets	3	6	9	12	18
	Field level, per Battery	1	”	”	”	”
	50-ft. tape, ditto	1	”	”	”	”
Materials.	Fascines, 18′ × 10″ diameter	7	14	21	33	52
	Pickets for ditto, 4 feet long	50	100	150	231	364
	Sap gabions, 33″ × 20″ diameter, for parapets and embrasures	24	48	72	112	176
	Gabions, for traverses, 3′ × 2′ diameter	48	”	”	48	96
	Sand-bags, 1-bushel	100	200	300	400	600

* Applied in Tools, only to pickaxes and shovels.

BATTERY TABLE IV.

Magazines for 3 Guns, at 240 rounds per Gun. See Plate II.	Magazines. 1	2	3	4
Sappers; Revetters and Builders	4	8	12	16
Line; Labourers to ditto	6	12	18	24
„ Diggers, Shovellers, and Rammers to Magazine	10	20	30	40
„ forming communication with Battery	16	32	48	64
Total	36	72	108	144
Pickaxes	12	24	36	48
Shovels	14	28	42	56
Rammers	3	6	9	12
Mallets, hand	2	4	6	8
Saws, hand	2	4	6	8
Hammers, large, claw	2	4	6	8
Spikes, 6-inch	50	100	150	200
Gimlets to ditto	2	4	6	8
Frame, common to all kinds: Baulks,* 10′ × 6″ × 6″	30	60	90	120
Frame, common to all kinds: Sills, (1 cap and 2 ground,) 15′ × 6″ × 6″	3	6	9	12
Frame, common to all kinds: Stanchions,† 6½′ × 6″ × 6″	5	10	15	20
Frame, common to all kinds: Mining frames and sheeting plank. Bays complete	3	6	9	12
Frame, common to all kinds: Tarpaulin, 17′ × 12′	1	2	3	4
If revetted internally (the back and one end) with				
Planks only; planks 15′ × 1′ × 1½″	9	18	27	36
„ 7′ × 1′ × 1½″	7	14	21	28
Fascines only; fascines 15′ × 10″ diameter	10	20	30	40
„ 7′ × 10″ diameter	9	18	27	36
Half fascine, half plank; fascines 15′ × 10″ diameter	6	12	18	24
„ 7′ × 10″ diameter	9	18	27	36
planks 15′ × 1′ × 1½″	6	12	18	24
Gabions only; gabions 3′ high × 2′ diameter	22	44	66	88
Half gabion, half plank; gabions do. do.	14	28	42	56
planks 15′ × 1′ × 1½″	6	12	18	24
Sand-bags only; sand-bags, bushel	450	900	1350	1800
Half sand-bag, half plank; sand-bags, bushel	300	600	900	1200
planks 15′ × 1′ × 1½″	6	12	18	24

* Lieut.-General Sir Chas. Pasley mentions 9″ × 6″; since then, however, the French experiments at Metz bear out the judgment of Sir J. F. Burgoyne, from whom the 6″ × 6″ scantling is taken as sufficient when covered, as shewn in the transverse section of this magazine.

† Not including tenons. It is assumed that the stanchions, cap sill, and ground sill, are sent with mortises and tenons complete.

BATTERY TABLE V.—See Plate III.

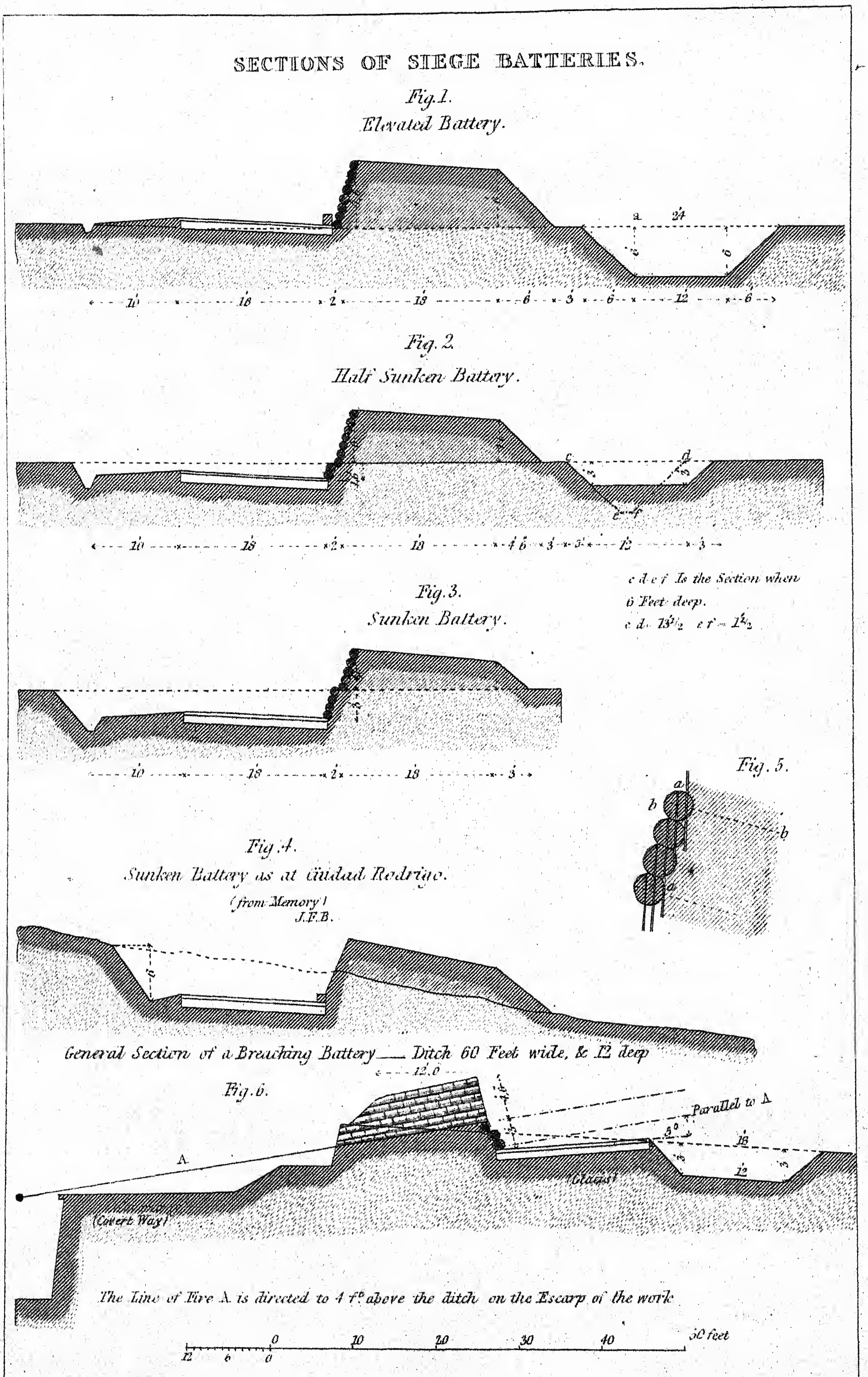
	Labour, Tools, and Materials, for laying (only) Platforms in Gun and Mortar Batteries.	Scantling. Gun.	Mortar.		Per Gun or Mortar, as Unit.	Guns or Mortars. 2	3	4	6
	COMMON OBLONG PATTERN.								
Labour.	Carpenters				2	4	6	8	12
	Labourers, cutting trenches, &c. &c.				2	4	6	8	12
	Total labour				4	8	12	16	24
Tools.	Adzes				1	2	3	4	6
	Axes, broad				1	2	3	4	6
	„ pick				2	4	6	8	12
	Augers, ¾-in.				2	4	6	8	12
	Levels, field				1	2	3	4	6
	Rammers, earth				2	4	6	8	12
	Saws, hand				2	4	6	8	12
	Spades				2	4	6	8	12
	Wrenches, screw				2	4	6	8	12
Materials.	Hurters	12′	„	× 6″ × 6″	1	2	3	4	6
	Sleepers	18′	8′	× 6″ × 5″	5	10	15	20	30
	Planks	12′	8′	× 1′ × 3″	18*	36	54	72	108
					8†	16	24	32	48
	Side ribands	18′	8′	× 9″ × 2″	2	4	6	8	12
	Screw-bolts (10″ × ¾″) and nuts				10*	20	30	40	60
					8†	16	24	32	48

* Gun platform. † Mortar platform.

BATTERY TABLE VI.

MADRAS PLATFORMS.—SEE PLATE III.

	Labour, Tools, and Materials; laying only.	1 Gun or Howitzer.	2	3	4	6
Labour.	Carpenters	2	4	6	8	12
	Labourers, cutting trenches, &c. &c.	2	4	6	8	12
	Total labour	4	8	12	16	24
Tools.	Axes, broad	1	2	3	4	6
	„ pick	2	4	6	8	12
	Augers, ½-inch	2	4	6	8	12
	Hammers, claw, large	1	2	3	4	6
	Levels, field	1	2	3	4	6
	Mallets, hand	1	2	3	4	6
	Rammers, earth	2	4	6	8	12
	Screw-drivers	2	4	6	8	12
	Spades	2	4	6	8	12
Materials.	Side pieces, complete	2	4	6	8	12
	Trail piece, ditto	1	2	3	4	6
	Head piece, or front transom	1	2	3	4	6
	Transoms, centre and rear	2	4	6	8	12
	Sleepers, 10 ft. long	1	2	3	4	6
	„ 8 ft. 3 in.	1	2	3	4	6
	„ 6 ft. 6 in., and pivot	1	2	3	4	6
	„ 6 ft.	1	2	3	4	6
	Iron tie-bolt and nut	1	2	3	4	6
	Screws—5-inch: No. 231	24	48	72	96	144



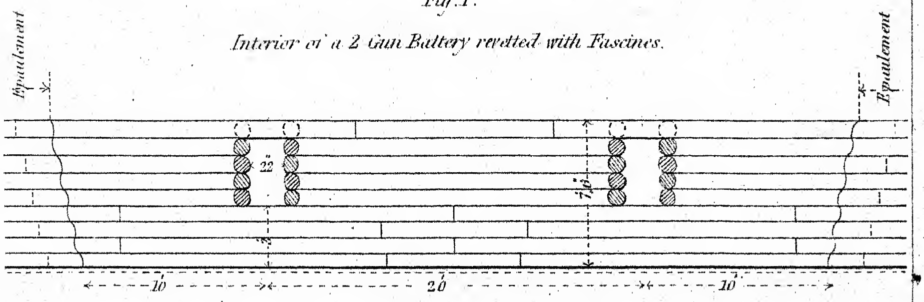
R.J.N. del.

J.W. Lowry fc.

John Weale, 59, High Holborn, 1845.

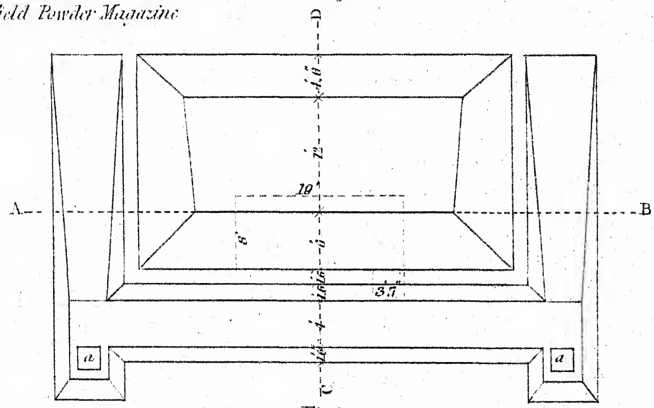
Fig. 1.

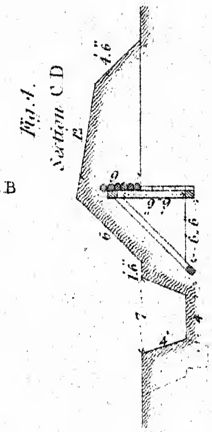
Interior of a 2 Gun Battery revetted with Fascines.



Figs. 2. 3. 4.
Plan and Sections of a Field Powder Magazine

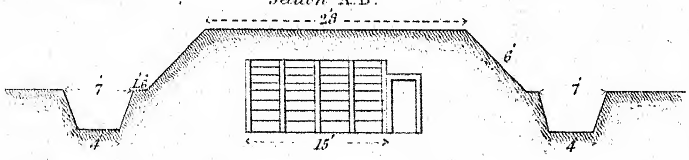
Fig. 2.





a a Cess-pools

Fig. 3.
Section A.B.



The above Magazine is capable of holding 55 Barrels of Powder.

Fig. 5.

Transverse Section of a Splinter Proof Traverse.

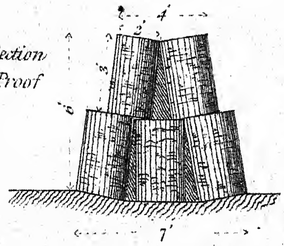


Fig. 6.

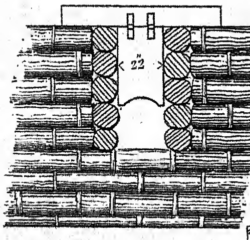
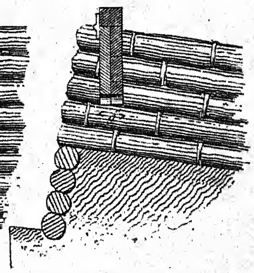


Fig. 7.



Figs. 6. 7. Mantlets for Embrazures of Breaching and Counter Batteries.

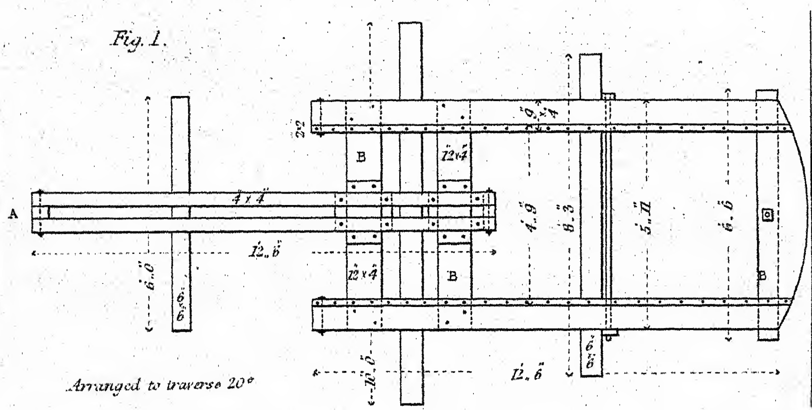
R. J. N. del.

J. W. Lowry sc.

John Weale, 59, High Holborn, 1845.

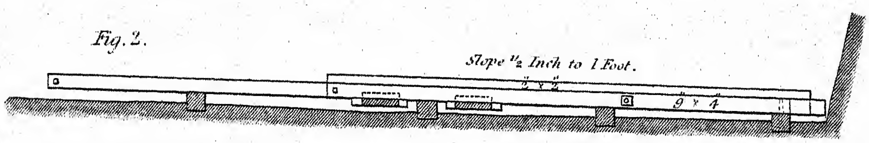
Figs 1. 2. MADRAS PLATFORM.

Fig. 1.



Arranged to traverse 20°

Fig. 2.



Figs 1. 2. Gun Platform for Travelling Carriages 24 Pr. or 18 Pr. By removing the Trail Plank A and shortening the Transoms B it will do for Garrison Carriages.

Figs 3. 4. COMMON GUN PLATFORM.

(laid with Screws instead of Spikes)

Fig. 3.

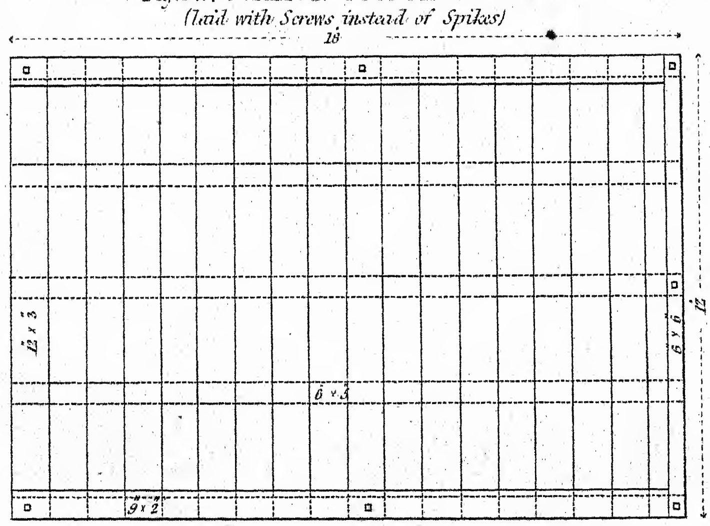
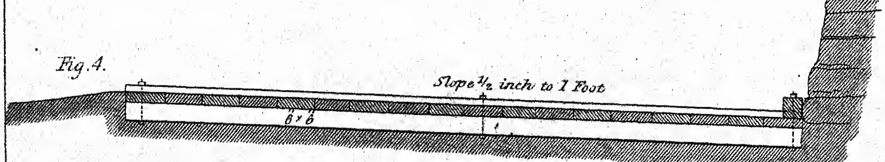
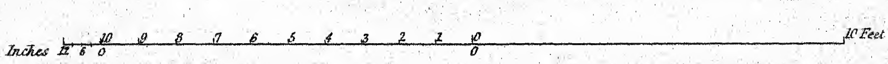


Fig. 4.





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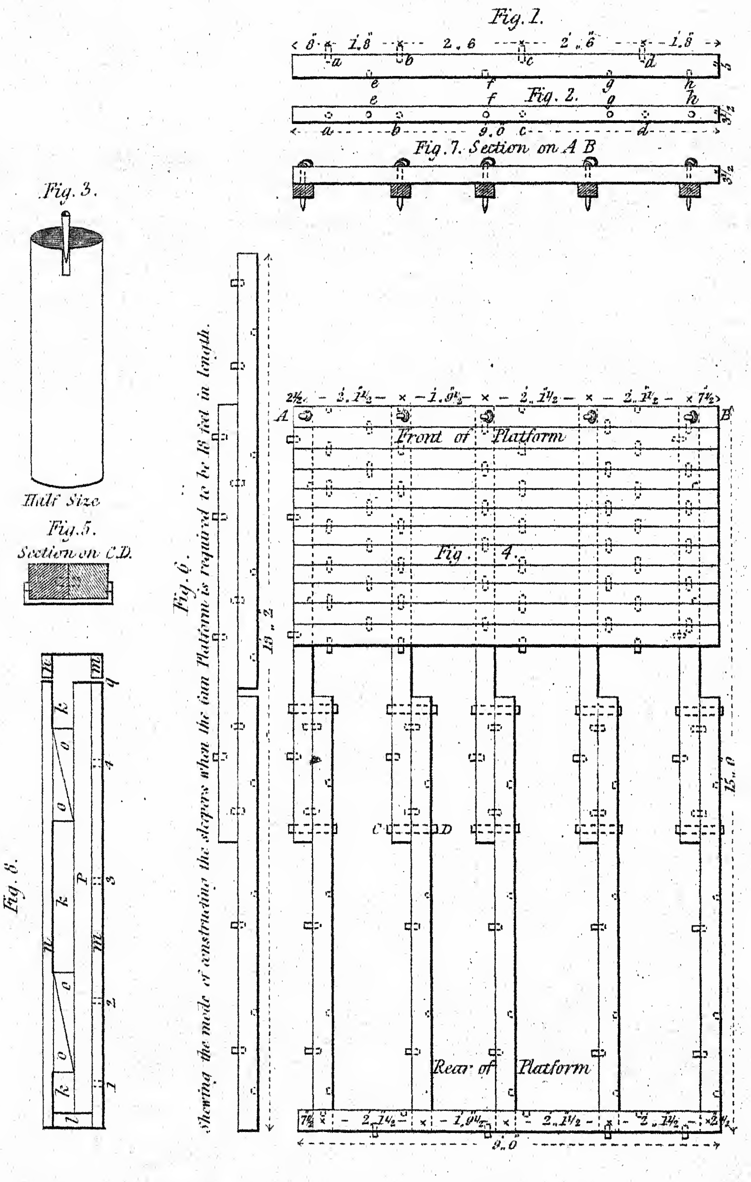
John Weale, 59, High Holborn, 1845.

SIEGE GUN PLATFORM.

by L^t. Colonel Alderson, R.E.



J.W. Lowry

John Weale, 59, High Holborn 1845.

BATTERY TABLE VII.

LIEUT.-COLONEL ALDERSON'S GUN PLATFORM. SEE PLATE IV.

	Labour, Tools, and Materials; laying only.	1 Gun or Howitzer.	2	3	4	6
	18-FT. PLATFORM, FOR GUNS ON TRAVELLING CARRIAGES.					
Labour.	Carpenters	3	6	9	12	18
	Labourers, cutting trenches, &c. &c.	2	4	6	8	12
	Total labour	5	10	15	20	30
Tools.	Axes, broad	1	2	3	4	6
	" pick	2	4	6	8	12
	Augers, $\frac{5}{8}$-inch	2	4	6	8	12
	Gimlets (to 1-inch screw)	2	4	6	8	12
	Hammers, claw, large	1	2	3	4	6
	Levels, field	1	2	3	4	6
	Mallets, hand	2	4	6	8	12
	Mauls, pin	1	2	3	4	6
	Rammers, earth	2	4	6	8	12
	Screw-drivers	2	4	6	8	12
	Spades	2	4	6	8	12
Materials.	Joists	54	108	162	216	324
	Dowels	216	432	648	864	1296
	Iron pins	10	20	30	40	60
	Iron shoes	10	20	30	40	60
	Screws to ditto, 1-inch, (No. 205)	20	40	60	80	120

BATTERY TABLE VIII.

LIEUT.-COLONEL ALDERSON'S 8 AND 10-INCH MORTAR PLATFORM.
SEE PAGE 148.

	Labour, Tools, and Materials; laying only.	1 Mortar.	2	3	4	6
Labour.	Carpenters	2	4	6	8	12
	Labourers, cutting trenches, &c. &c.	2	4	6	8	12
	Total labour	4	8	12	16	24
Tools.	Axes, broad	1	2	3	4	6
	" pick	2	4	6	8	12
	Augers, $\frac{5}{8}$-inch	2	4	6	8	12
	Hammers, claw, large	1	2	3	4	6
	Levels, field	1	2	3	4	6
	Mallets, hand	2	4	6	8	12
	Mauls, pin	1	2	3	4	6
	Rammers, earth	2	4	6	8	12
	Spades	2	4	6	8	12
Materials.	Joists	27	54	81	108	162
	Dowels	108	216	324	432	648
	Iron pins	10	20	30	40	60

BLINDAGE.

Prior to the Wars of the Revolution, Cormontaingne's section, Plate I. fig. 1, seems to have been regarded as the model.

But the difficulty and expense of procuring such a quantity of $12\frac{3}{4}$-inch baulk as would be required for a tolerably large garrison, and the inconvenience and labour in managing such weighty beams, suggested to M. de Senermont the arrangement given in fig. 2. Though it has not been tested by experiment, those hereafter detailed leave no doubt as to its sufficient strength: it is given here as worth recollection when only small scantling can be obtained; but it must be well bridged and stiffened laterally; and it is recommended that about one plank in ten be let a foot into the wall, at each end, as at *o*, fig. 4.

By the experiments at Douay, in 1826–29, it appears that with reference to

HORIZONTAL BLINDAGE,

1st. A single course of naked contiguous beams 12″ × 12″, with a bearing of $16\frac{1}{2}$ feet, is *not* proof against shells* at a range of 670 yards; it may stand the first shell, but not a second on or near the same place.

2nd. Neither is such a course of beams secured by a single layer of fascines, brushwood, &c., as no lateral resistance is made to the shell, which easily pierces through this covering.

3rd. But one such course is perfectly proof when covered by two layers of fascines, crossing each other (without any earth or dung); or even by $2\frac{1}{2}$ feet of dung, without fascines.

4th. Also, one course of such beams, 6 inches apart,† is proof, if covered with two of crossed fascines; or one of fascines, and 40 inches of earth; or by a course of baulks 12″ × 12″, laid touching each other.

SLOPING BLINDAGES.

Baulks 20′ 6″ long, 12″ × 12″, 6 inches apart, and naked, are not proof; neither are they so with one layer of fascines; but they are perfectly so when covered with a course of contiguous beams of the same scantling; or by a bed of earth, from 3′ 6″ to 6′ thick, as in fig. 4, Plate III.

The blindages that resisted the shock of the shell were all proof against the bursting; the action of which last seemed much less energetic than that of the shock. This, it is to be observed, is an important principle in the construction of casemates.

Hence, *all* blindages may be considered proof if made of 12″ × 12″ scantling, with a bearing of $16\frac{1}{2}$ feet, and covered with two crossed courses of fascines; or with 3 to 6 feet of earth; or with a second course of contiguous beams, also 12″ × 12″. The latter would, however, occasion a great consumption of materials not easily provided.‡

This conclusion is supported by the fact, that at the siege of Antwerp in 1832, a mortar battery 18′ × 12′ in the clear, roofed with one course of $6\frac{1}{2}$″ to $7\frac{1}{2}$″ spars, three courses of fascines, and 3′ to 4′ of earth,—on side walls of five stanchions 8″ × 16″, and 8-inch framing,—stood proof, though struck by many shells; whilst a gun battery, built in like manner, except that no provision was made against the side thrust of the shells, fell at the first blow, and disabled the gun beneath it. There are other

* Size and elevation not given; presumed from the context to be 8-inch shells at 45°, at least.

† An 8-inch shell would find its way through, if farther apart.

‡ See 'Field, Fort.'

precedents and experiments recorded by Djiobeck in his 'Taschenbuch,' on the requisite strength for blindages against 11-inch shells; but there is nothing in contravention of the principles laid down above.

Blindages made with Small Scantling.

The following experiments were also made at Douay:

1. Two courses of 5″·6 × 5″·6 scantling, 20′ 6″ bearing; the pieces 6¾ inches apart, and covered by one layer of fascines, without earth.

2. Ditto, but the pieces in the lower course contiguous.

3. One course of 5″·2 scantling, with 18′ 3″ bearing; pieces touching each other, covered with a bed of saucissons, and 40 inches of earth.

Nos. 1 and 2 were penetrated by shells* at 890 yards.

No. 3 was broken by only two shells out of the fifteen that reached it; hence it is too weak; but the experiment is sufficient to shew that small scantling may be used when larger timber cannot be had.

In the following, the preceding data have been assumed as the basis of construction.

Blindages may be required for Batteries, Magazines, Stores, Hospitals, or Barracks.

When for Gun Batteries, Plate II. gives the details, if behind a full parapet. The side farthest from the enemy only is made splinter-proof by 6-inch scantling, wedged in between the stanchions, as at *c*, fig. 2, and the whole secured by gabions. The struts, *f*, are indispensable to resist the side thrust of the shells. The heart of the outer side, *g*, is built up with dry rubble to relieve the planking from the lateral pressure.

When a Battery is to be placed behind a Barbette Parapet, such as A *c*, fig. 2, Plate III., perhaps only 18 feet thick, there will be some difficulty in forming a face for the height above the low crest, *c*, that would be proof: if formed of ordinary timber, as was done at the siege of Dantzic, (vide Laisné, 2nd edit. p. 421,) and as given in the 'Aide-Mémoire à l'usage des Officiers d'Artillerie,' 1844, it could scarcely be less than 8 or 9 feet thick, and would thus occasion considerable waste. It is therefore best, in this case, to complete the barbette section to that of the full parapet as given in Plate II., by withdrawing 24 feet from the cordon, so as to have 18 feet thickness of parapet and 6 feet exterior slope; revetting the interior of the parapet and the cheeks of the embrasures, as shewn in figs. 1, 2, Plate III. We are then in the position of Plate I., and the blindage can be completed exactly as before. The thickness, *d*, *d*, must depend on the fire, either direct or oblique, to which the battery will be exposed.

This blindage is intended only to be placed where it is not exposed to direct fire, and has been seldom used except in such positions; but experiments on the Continent have proved that by laying beams 12″ × 8″ over a portion of the embrasure, and covering them with earth 4 feet thick, a protection is thus formed in front of the roof of the blindage which enables it to resist a great deal of direct fire, and renders it much more secure against shells.

In Djiobeck's 'Taschenbuch' some account is given of a Blinded Mortar Battery used at Antwerp, 1832, but not with sufficient detail to enable a drawing to be made. It was probably the Gun Blindage, open at both ends, much on the principle of the casemated mortar batteries at Coblenz, which are little more than bomb-proof piazzas.

---

* Size and elevation, as before, not specified; neither is the nature of the timber: in the account of these experiments in the 'Aide-Mémoire à l'usage de l'Artillerie,' 1844, oak is mentioned; but it is shewn above that the sections, Plates II. and III., are strong enough.

For Magazines attached to Siege Batteries, see 'Battery.' When they, or stores, are to be placed in houses for defence of places, dry cellars will be best, properly protected above.

Blindages for Hospitals or Barracks are best made in low strong buildings, with walls, if possible, not less than 3 feet thick, though this seldom occurs but in ecclesiastical or other public buildings, where however the walls are lofty. If a low second story can be arranged under the same cover, so much the better. When blindages are to be inhabited, the sand, earth, &c., should be kept from falling through by a course of sand-bags, as at *g*, fig. 3, Plate I.

Splinter-proofs, either for hospitals, barracks, or stores, can be made, as in Plate III. fig. 3, wide enough for a man to lay down in, at the rear of the retaining wall of a rampart; or against the counterscarp, on a side not likely to be attacked. When, however, the site can be reached by shells, or when a magazine is wanted, fig. 4, Plate III., is the smallest that can be advisably constructed.

If a building has to be blinded horizontally, as in Plate I., the external abutments can be obtained by running the splinter-proofs or bomb-proofs round it, that will be required for barracks, &c.

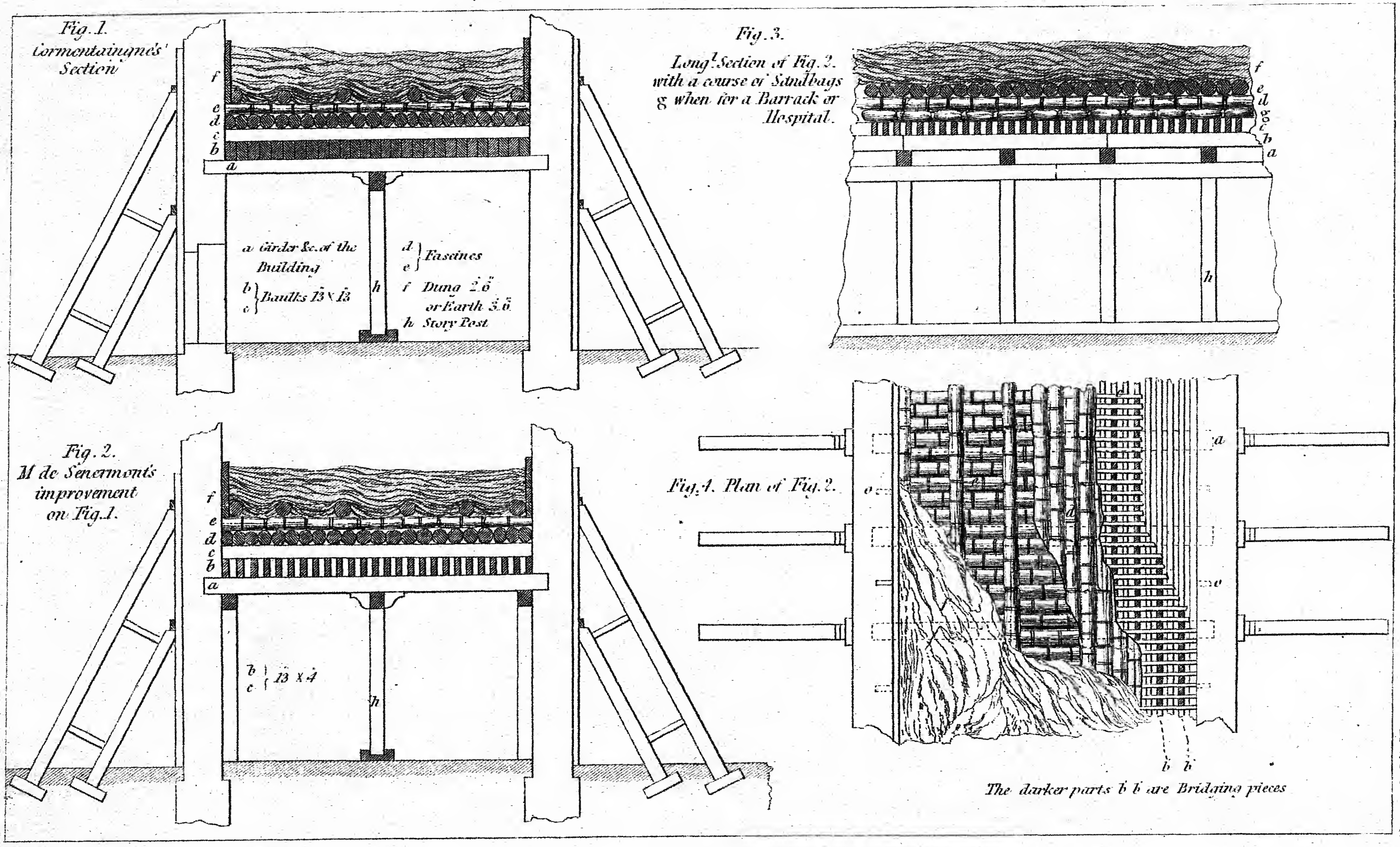
The following Table gives some little information as to what is splinter-proof.

Numbers and Range of Splinters, given by French and Prussian Shells, from Experiments.

French and Prussian Denom^ns.	c. 32	pr. 50	c. 27	pr. 25	c. 22	pr. 10	c. 16	pr. 7	c. 15	c. 12
Approx. diam. in English inches.	$12\frac{3}{5}$	11	$10\frac{2}{3}$	$8\frac{3}{4}$	$8\frac{2}{3}$	$6\frac{1}{2}$	$6\frac{3}{10}$	$5\frac{2}{3}$	$5\frac{9}{10}$	$4\frac{3}{4}$
Bursting charge, lbs. . . .	8	$3\frac{1}{7}$	$4\frac{3}{4}$	$2\frac{1}{12}$	$2\frac{1}{10}$	1	1	$\frac{3}{4}$	$\frac{4}{5}$	$\frac{1}{2}$
Number of splinters . . .	22	10—15	18	14—16	33	18—19	21	16—17	22	17
Weight of greatest splinter, lbs.	..	16	..	9	..	$2\frac{1}{2}$	..	2	..	..
Ditto of smallest ditto, oz. .	..	10	..	13	..	5	..	2	..	..
No. of splinters weighing more than $2\frac{1}{4}$ lbs.	22	..	18	..	28	..	17	..	19	14
Extreme range* of splinters, yards	..	750	..	500	..	420	..	350	..	..

R. J. N.

* The French splinters ranged from 650 to 900 yards. In the above, 'c.' is centimetre, and 'pr.' the peculiar mode the Germans have of denominating their mortars and howitzers, which has a very different meaning from our term of 'pounder.' Their 7-pr. howitzer has the same calibre as their 24-pr. gun, of which the shot weighs 24 lbs. Prussian, the 7 lbs. being the assumed weight of a stone ball of the same diameter. The splinters of the 10-pr. and 7-pr. did not penetrate a $3\frac{3}{4}$-inch board, close to them; those of the 25-pr, and 50-pr. did. The nature of the wood is not stated.



J.W. Lowry fc.

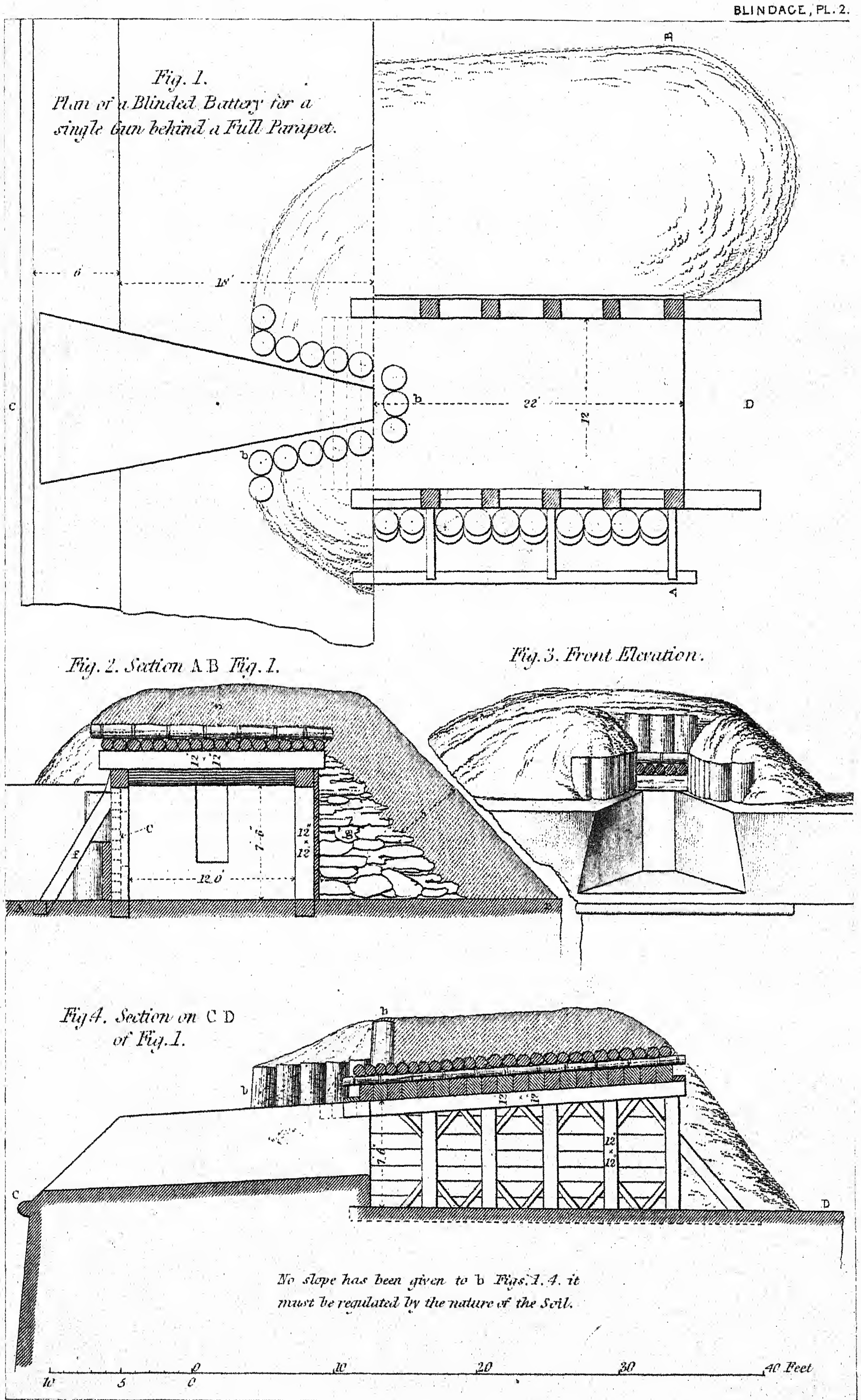
John Weale, 59, High Holborn, 1844.

Fig. 1.
Plan of a Blinded Battery for a single Gun behind a Full Parapet.

Fig. 2. Section A B Fig. 1.

Fig. 3. Front Elevation.

Fig 4. Section on C D of Fig. 1.

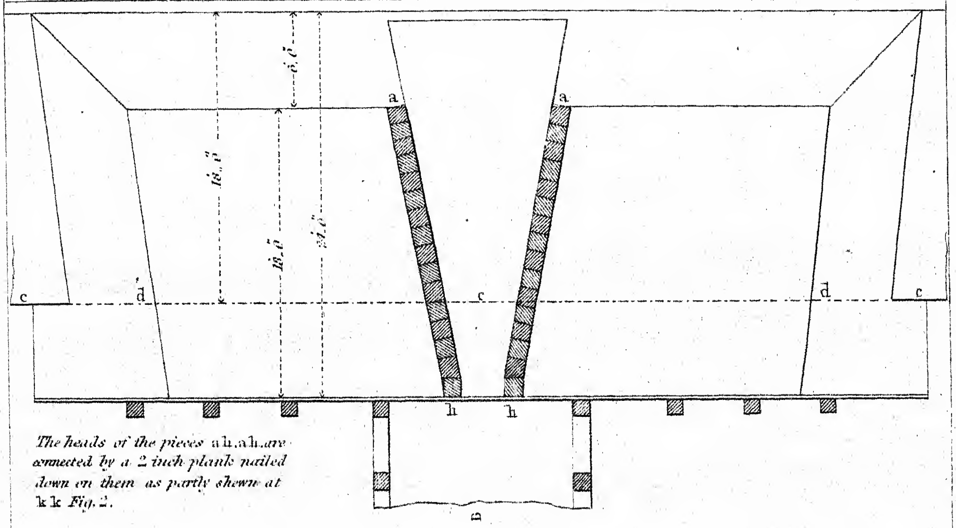


R.J.N. del.

J.W. Lowry fc.

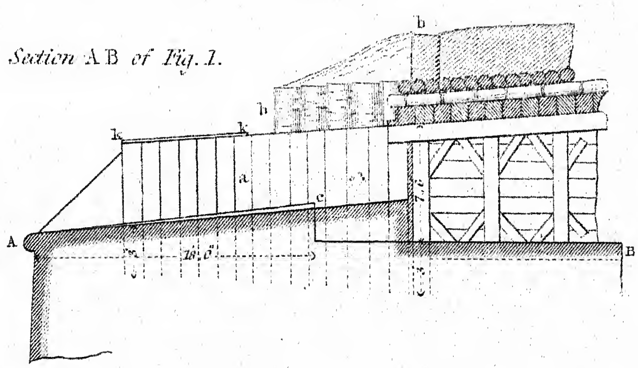
John Weale 59 High Holborn 1845.

Fig. 1.——Plan of a Blinded Battery for a Single Gun behind a Barbette Parapet.



The heads of the pieces a h, a h, *are connected by a 2 inch plank nailed down on them as partly shewn at* k k *Fig. 2.*

Fig. 2. Section A B *of Fig. 1.*



No slope has been given to a & b *in Figs. 1. 2. it must be regulated by the nature of the Soil.*

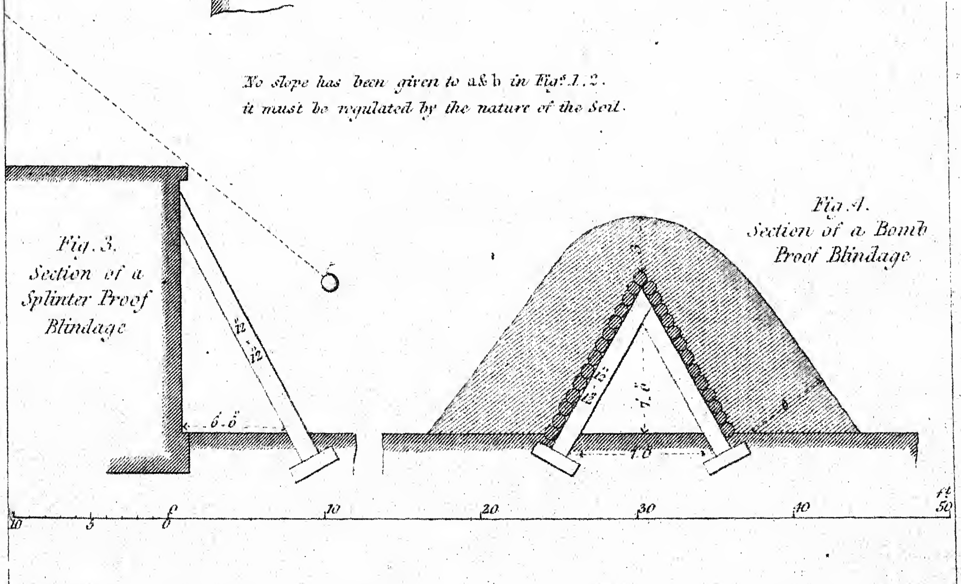


Fig. 3. Section of a Splinter Proof Blindage

Fig. 4. Section of a Bomb Proof Blindage

R. J. N. del. — J. W. Lowry fc.

John Weale 59 High Holborn, 1845.

BLOCK.*

WEIGHT OF BLOCKS, AND SIZES OF THEIR PROPER ROPES.

Wood.				Iron.				Metal.				Size of Rope to correspond.
Length of block.	Single.	Double.	Treble.	Length of block.	Single.	Double.	Treble.	Length of block.	Single.	Double.	Treble.	
inches.	lbs.	lbs.	lbs.	inches.	lbs.	lbs.	lbs.	inches.	lbs.	lbs.	lbs.	inches.
26	92·00	142·00	192·00									9
24	67·00	106·00	146·00									8½
22	57·00	84·00	130·00									8
21	51·00	78·00	108·00									8
20	49·00	72·00	104·00									7½
18	35·00	56·00	78·00									6½
17	27·00	45·00	65·00									5½
15	19·00	34·00	40·00									5
14	16·00	28·00	37·00									4½
12	10·50	17·00	26·00									3½
11	8·25	13·00	18·00					9	22·00			3½
10	6·00	10·00	14·00					8	16·00			3
9	4·50	7·75	9·00	7		17·00	20·00	7	14·00	25·00		2½
7	2·25	3·75	6·00	6			16·00	6	12·00	18·00		2
6	1·72	2·75	4·50	5			11·00	5	7·00	14·00		1½
5	1·25	1·50	2·25	4		4·00		4	4·00			1½
4	·75	1·00	1·25									1

G. B.

BLOCKADE, MILITARY.—As a rule for Blockading a Fortress, and reducing it without a siege operation, and effectually confining the garrison within the works by a circle of fortified posts, the following narrative of the Blockade of Pampeluna is taken from Sir John Jones's 'Journals of Sieges.'

"The duties of the blockade were confided to Lord Dalhousie, with the 6th and 7th Divisions of Infantry.

"For the more effectual confinement of the garrison of Pampeluna, and to strengthen the front of the blockading corps, the Marquis of Wellington ordered works to be thrown up all round the place, on the nearest heights favourably situated to command the several roads and communications. Nine redoubts, calculated for garrisons from 200 to 300 men each, were, in consequence, immediately marked out on commanding points from 1200 to 1500 yards from the fortress. The redoubts were ordered to be made of a strong field profile, and to be armed with the French field guns captured at Vittoria, firing through embrasures.

"The investing force furnished strong parties, which worked by regular reliefs throughout the day; but the greater portion of the labour was performed by the peasantry of the country, put into requisition for this service by the Spanish authorities.

"Neither the peasantry nor the soldiers received any working pay; nevertheless, through a vigilant superintendence and the exertions of the Officers, the whole chain of redoubts was speedily in a state of defence. Garrisons were allotted to the several

---

* As used in the Navy.

works, which were kept in them constantly prepared to receive and repel any attack; but the remainder of the blockading force was either placed under cover in the villages, or bivouacked on favourable spots just without the fire of the place; the whole, however, being in constant readiness to form under arms at their several alarm posts on the first intimation of the garrison making a sortie.

"In the middle of July, Marshal Soult being in march with a very strong force to the relief of Pampeluna, it became necessary to concentrate all the British and Portuguese forces in the Pyrenees to oppose him; and, in consequence, the blockade was transferred to the Spanish Army of Reserve of the Conde de Abisbal, and subsequently, on the 28th July, was intrusted to Don Carlos de España, with a force of Spaniards not exceeding 8000 or 9000 men.

"Under these circumstances, increased exertions were made to strengthen the several defences of the blockading line.

"Several buildings near the place were barricaded and formed into strong advanced posts; the passage along the roads was obstructed in various places; flèches were thrown up to protect the guards, and signal posts were established to communicate intelligence and orders round the whole blockading circle.

"At the period when the army of Marshal Soult had penetrated to within a few miles of the fortress, and a desperate sortie might naturally be expected, all the advanced posts were reinforced at night, and chains of sentries were pushed out in advance, to guard against surprise on the passage of an individual, and the whole blockading force remained under arms, prepared to repel any powerful effort. These precautions succeeded in preventing a single communication of any kind passing between the garrison and the force engaged for their relief, on the 28th, 29th, and 30th July, almost within view of the ramparts.

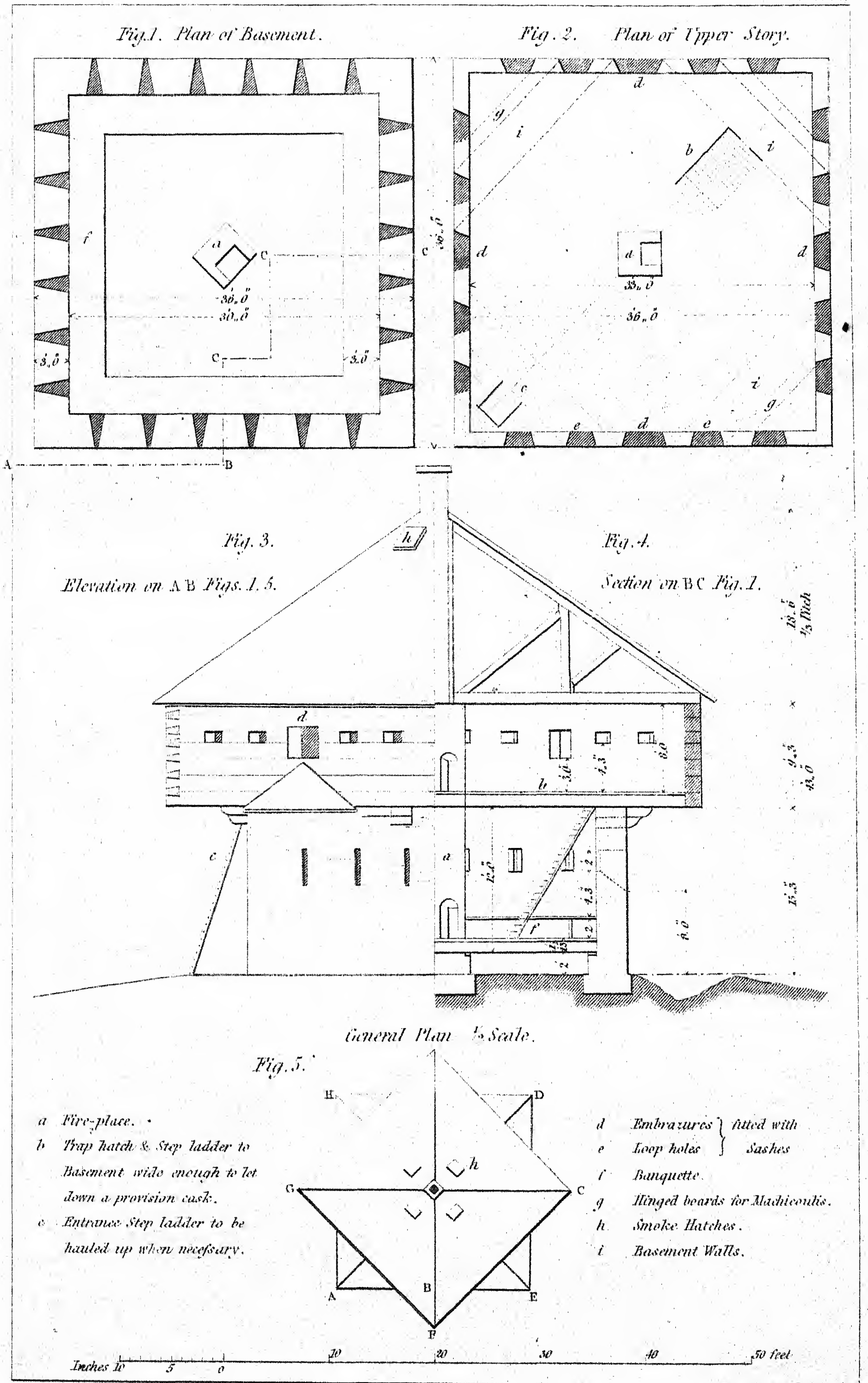
"The blockade of Pampeluna having been well regulated, admitted of no brilliant actions; but the duties and labours of the troops, in consequence of the smallness of their numbers, were, from its commencement to its termination, constant and great. Their vigilance never relaxed for a moment, and in every sortie the garrison was firmly met and quickly repulsed.

"This blockade is probably a solitary instance of the investment of a large place, situated close to its own frontier, having been so successfully maintained, for the long period of three months, as to preclude the garrison from once communicating with, or receiving intelligence from, their friends.

"On the other hand, the French Governor, Baron Cassan, is justly entitled to the highest degree of praise, for having driven off his submission till the latest possible moment, by inducing his garrison to be satisfied with very slender rations of inferior food; and under such circumstances to perform the duties of a blockaded place, with far more than the usual vigour and activity."

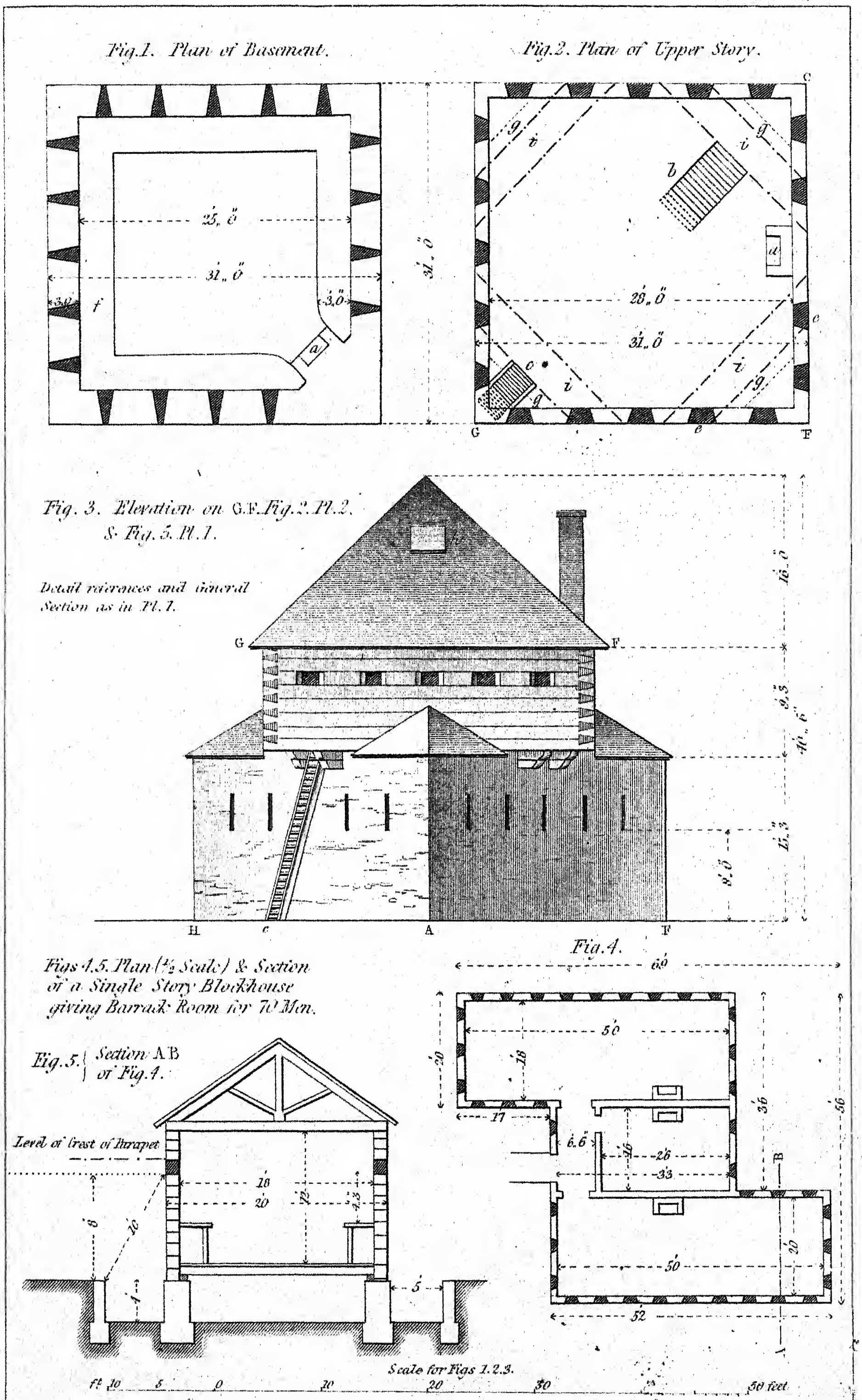
BLOCKHOUSE.—The Blockhouse occupies much the same place in temporary works that the Tower does in permanent fortification, although the former is by no means so secure from destruction, as it may be fired by carcass rockets or by howitzer carcasses, or rendered untenable by smoke-balls. Hence the best application for a Blockhouse is as the Keep to a field-work, or in the occupation of a point not easily accessible to the enemy.

In the designs given, therefore, no provision has been made for storing ammunition as if for an independent work, conceiving that a small expense magazine under the



R.J.N. del. J.W. Lowry fc.

John Weale, 59, High Holborn, 1844.



R.J.N. del.

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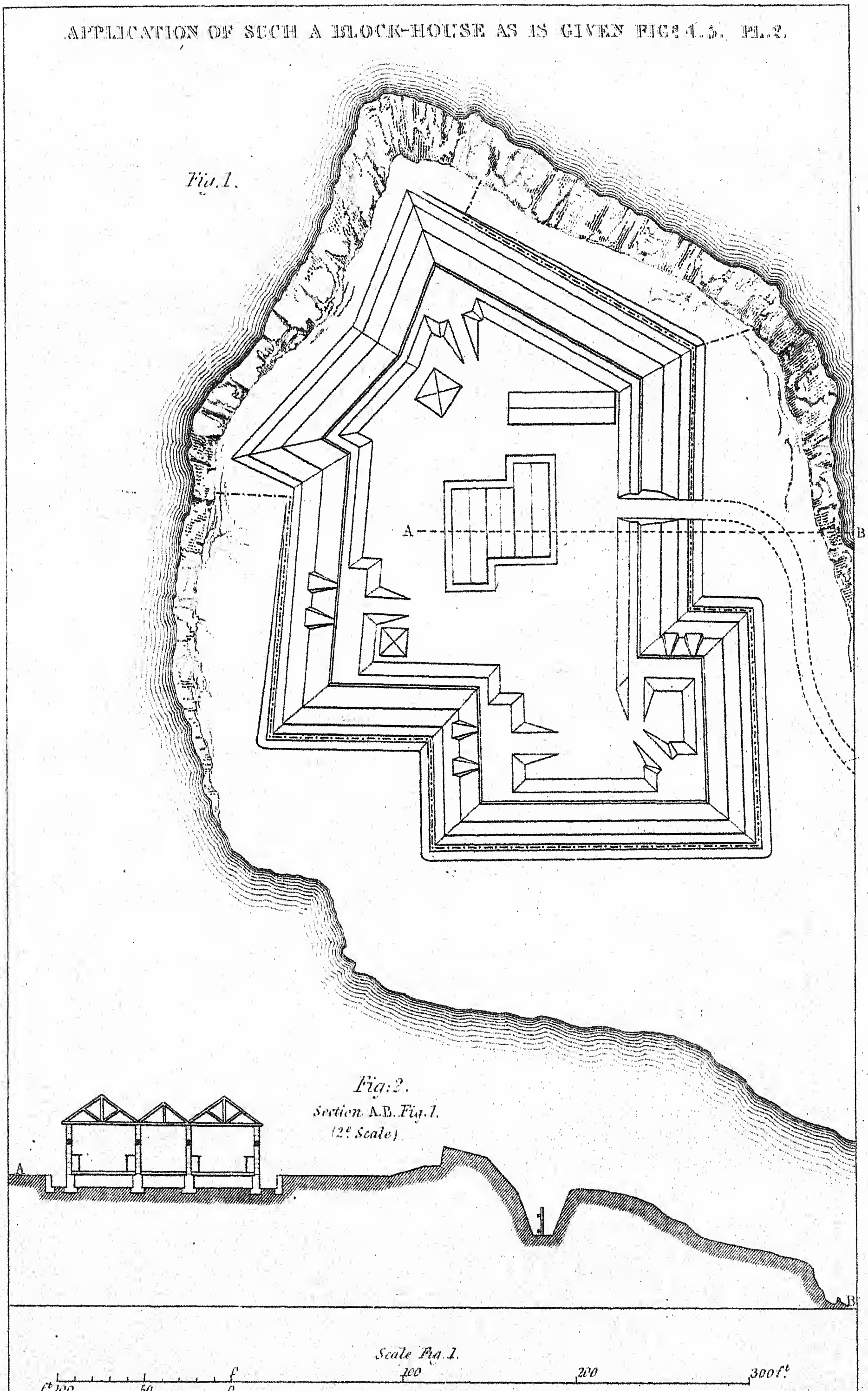
John Weale, 59, High Holborn, 1844.



John Weale, 59, High Holborn 1841.

floor will suffice for immediate defence, leaving the basement available as a barrack-room, or as a store generally.

The description of Blockhouse given in Plate I., and in Plate II. figs. 1, 2, 3, has the great advantage, over those of the ordinary form,* of protecting its salients; and if the hinged planks, *g*, fig. 2, be turned up, a respectable machicoulis is obtained.

In Plate I. the upper story is pierced for 4 carronades or other light ordnance, fitted with breeching as on board ship.

In Plate II. figs. 1, 2, 3, no artillery is supposed to be necessary, but the musketry of the upper story will fire over and extend beyond the work: in figs. 4, 5, the sphere is entirely limited by the works in front, to which it is the keep.

Besides these, however, there are various other forms and constructions; sometimes hexagonal (as at Mondragon, near Guipuscoa, North Spain), with a sunken basement, a ground-floor, and a flat roof with loopholed parapet walls, projecting as machicoulis. The following are the main details of a square American Blockhouse on the Fish River, near the mouth of the Madawaska. Basement and ground-floor, each 25′ × 25′ in the clear; the former lined with masonry,—the latter, as well as the upper story, of logs, 18″ square in ground-floor, 12″ square in upper story. Height of each story 10 feet; 29 loopholes; roof hipped, with a dormer window on each side; embrasures in upper story, one on each side; stories conformable,—the upper projecting 3 feet all round, as machicoulis, beyond the ground-floor, and thus 32′ × 32′ within.

When hatches are made in the roof for the escape of smoke, they should be grated, to prevent grenades or combustibles from being thrown in; and when in an exposed situation, the roofs should be covered with zinc, sheet iron, or (as in Canada) with tin.

Wind-mills generally occupy prominent points of ground; and when large, and otherwise suitable, the lower part may be turned to account as the basement for a blockhouse.

For the general management in building with logs, we may merely observe, that in the largest blockhouse the logs can be raised and easily placed in their exact position by a common derrick and guys.—See 'Derrick.'

R. J. N.

BOAT.—Under this head are given,—Plate I., Lines for a Ship's Launch; Plate II., Carronade Fitments for ditto; Plate III., Lines for a Four-oared Gig; Plate IV., Lines for a Dingy.

To avoid errors from the small scale of the Plates, the following Tables of dimensions are appended, which have been measured from authentic drawings on a large scale: everything is given in inches to the nearest quarter.

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* Stories conformable,—upper, projecting as machicoulis all round, beyond ground-floor.

DIMENSIONS OF BOATS.

The Launch.—Plate I.

Vertical Sections.		⊕	A	B	C	D	E	F	1	2	3	4	5	6	7	8	9	⊕	10*
Distances between Vertical Sections.		27·76 in every instance.																	
Horizontal Sections.	⊕	64½	63½	62½	60½	56¼	48	33	64¼	64	63¾	62½	61½	59	56¼	52	46	64½	,,
	a	62½	61	58½	54	46½	35	19	62¼	62	61¼	59¼	57¼	53	46	34½	16	62½	,,
	b	53	51	47¼	41¼	32½	21½	9¼	53½	53¼	51½	48¾	43¾	36½	26½	15½	5	53	,,
Oblique Sections.	V′W	64½	,,	,,	,,	,,	,,	,,	,,	,,	63¼	62¾	61½	59¼	56¼	52	46½	,,	40½
	V′X	70	,,	,,	,,	,,	,,	,,	,,	,,	69¼	67¾	65¼	62	58	51¼	43	,,	35½
	VY	64¾	63¾	63	61	56½	48	33½	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
	VW	72	70¾	69	56	59	50	34½	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

* 10 is the stern of the boat, not a vertical section.

=

VV′ = 5½
V′a = 32
V′b = 44
V′c = 56
YZ = 29 = WX
Zc = 24

The Four-oared Gig.—Plate III.

Vertical Sections.		⊕	A	B	C	1	2	3	⊕	4*
Distances between Vertical Sections.		⊕ to A 29½	A to B 27	B to C 27		⊕ to 1 29	1 to 2 43	2 to 3 38½		
Horizontal Sections.	⊕	33	31½	27	16	32¼	28¾	21½	33	,,
	a	31¾	30¼	25	12	31¼	25¼	10	31¾	,,
	b	29¼	27½	21	8½	28¼	19¾	5½	29¼	,,
	c	25	22¼	15	4½	23	12	2¾	25	,,
Oblique Sections.	VW	32¾	,,	,,	,,	32	28½	21½	,,	14½
	VX	35¾	,,	,,	,,	35	30	21½	,,	13½
	VY	32¾	31¾	27½	16	,,	,,	,,	,,	,,
	VZ	35¾	34½	29¼	17¼	,,	,,	,,	,,	,,

* 4 is the stern of the boat, not a vertical section.

=

Va = 16
Vb = 21
Vc = 26
Vd = 31
YZ = 12 = WX
Zd = 15

The Dingy.—Plate IV.

Vertical Sections.		⊕	A	B	C	1	2	3	4	5	⊕	6*
Distances between Vertical Sections.		Between 4 and C 17 in every instance.								4 to 5 14		
Horizontal Sections.	⊕	30½	30	27¾	21	30¼	29½	27¾	24½	20½	30½	,,
	a	29¼	27¾	23	14	29	27¾	25¼	20	10¼	29¼	,,
	b	27	24¾	19½	10	26½	24¾	20¾	13¾	5	27	,,
	c	21½	19	13½	5½	21¼	18½	13¼	6½	1¾	21½	,,
Oblique Sections.	VW	30¼	,,	,,	,,	,,	29	27¾	24¾	20½	,,	16½
	VX	34¼	,,	,,	,,	,,	32½	30½	26¾	21¾	,,	17½
	VY	30¼	29¾	28¼	21	,,	,,	,,	,,	,,	,,	,,
	VZ	34¼	33	29	21¼	,,	,,	,,	,,	,,	,,	,,

* 6 is the stern of the boat, not a vertical section.

=

Va = 17½
Vb = 21½
Vc = 25½
Vd = 29½
YZ = 14 = WX
Zd = 12

R. J. N.

DRAWING OF A LAUNCH OF 40 FEET.

	Ft.	In.
Length	40 .	0
Breadth	10 .	9
Depth	4 .	5

For dimensions, see Table.

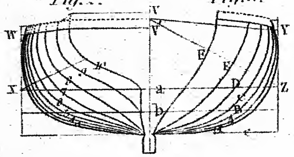
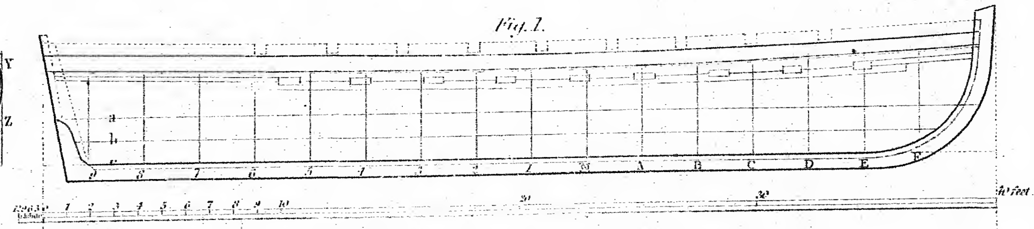


Fig. 2. Fig. 3.

Fig. 1.



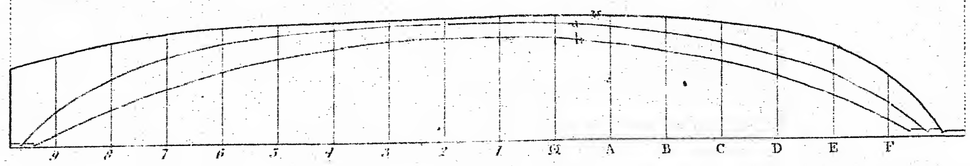
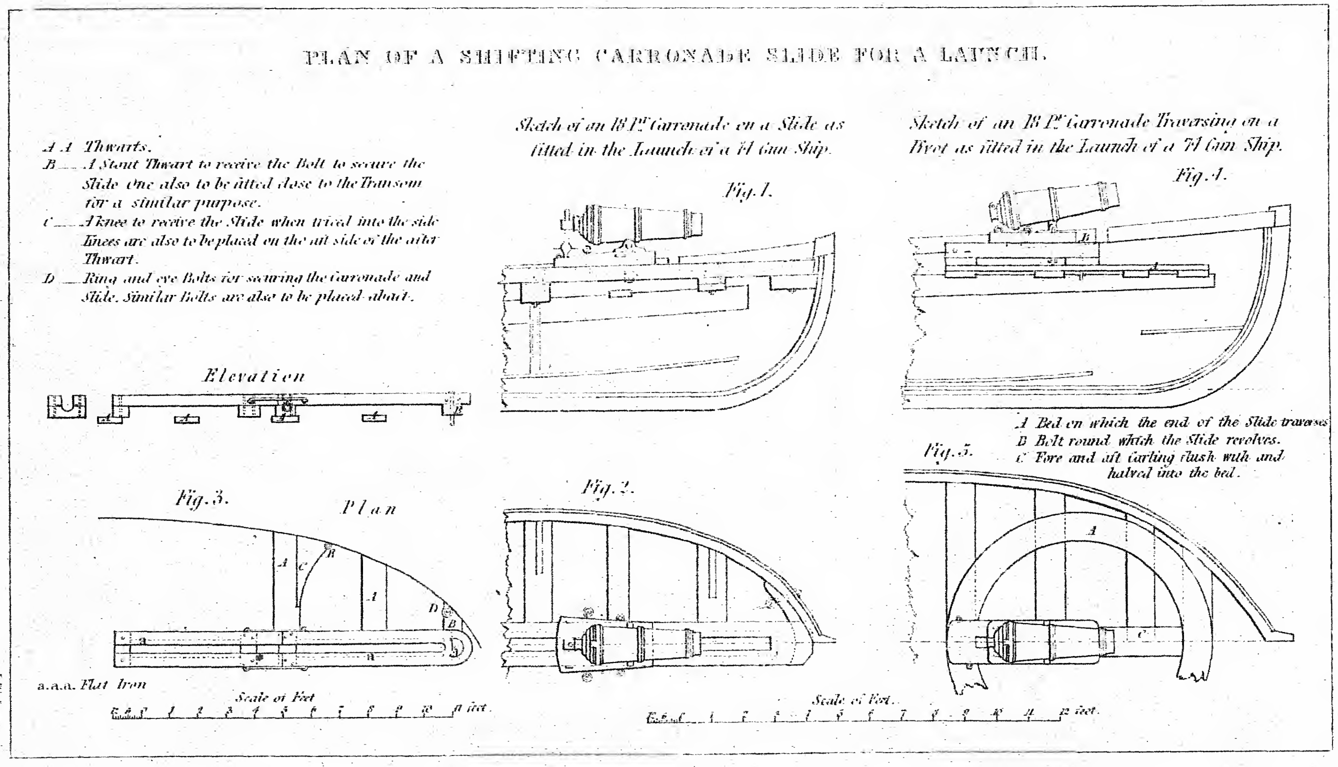


Fig. 4.

N.B. The Curve marked W in Fig. 2 is the Stern of the Boat and is not a Section. Nos. 1. 2. of Figs. 1. 4. are not given in Fig. 2.

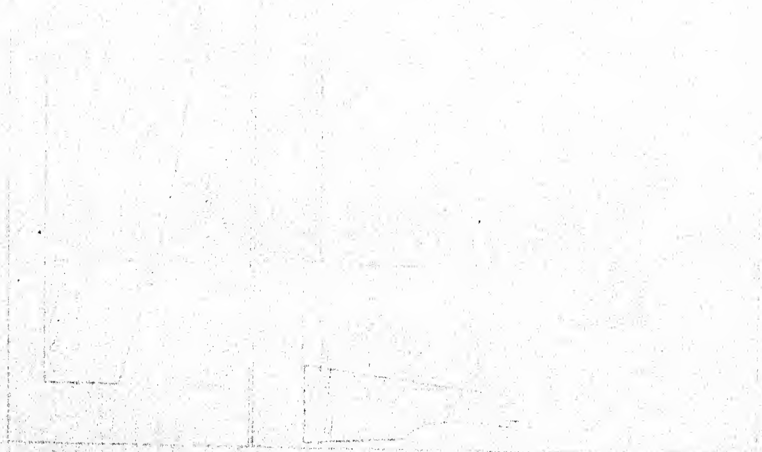
John Weale, 59, High Holborn, 1841.

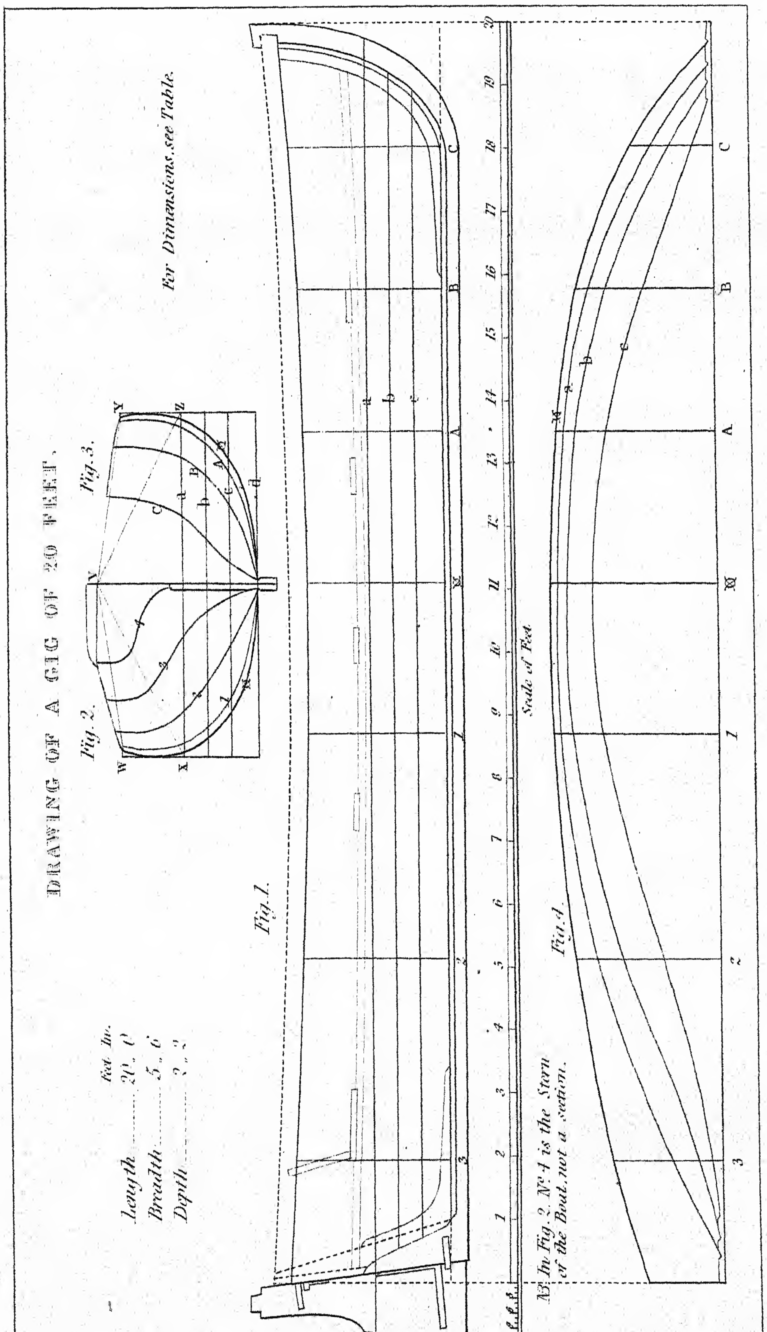
J.W. Lowry fc.



J. W. Lowry fc.

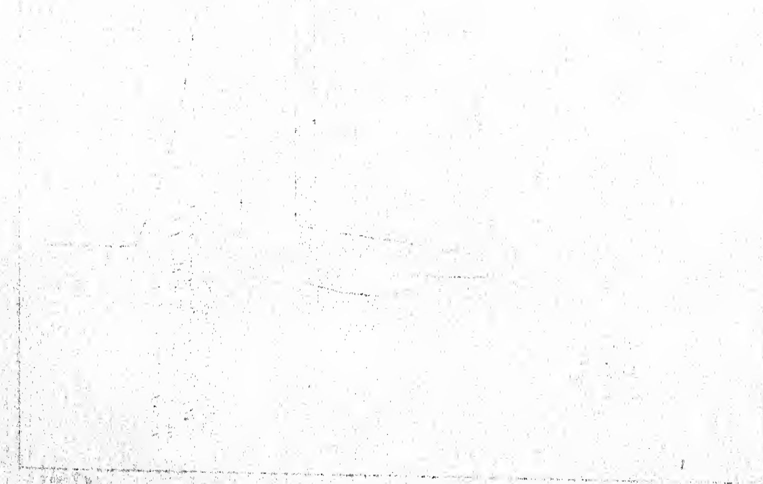
John Weale, 59, High Holborn, 1841.





J. W. Lowry fc.

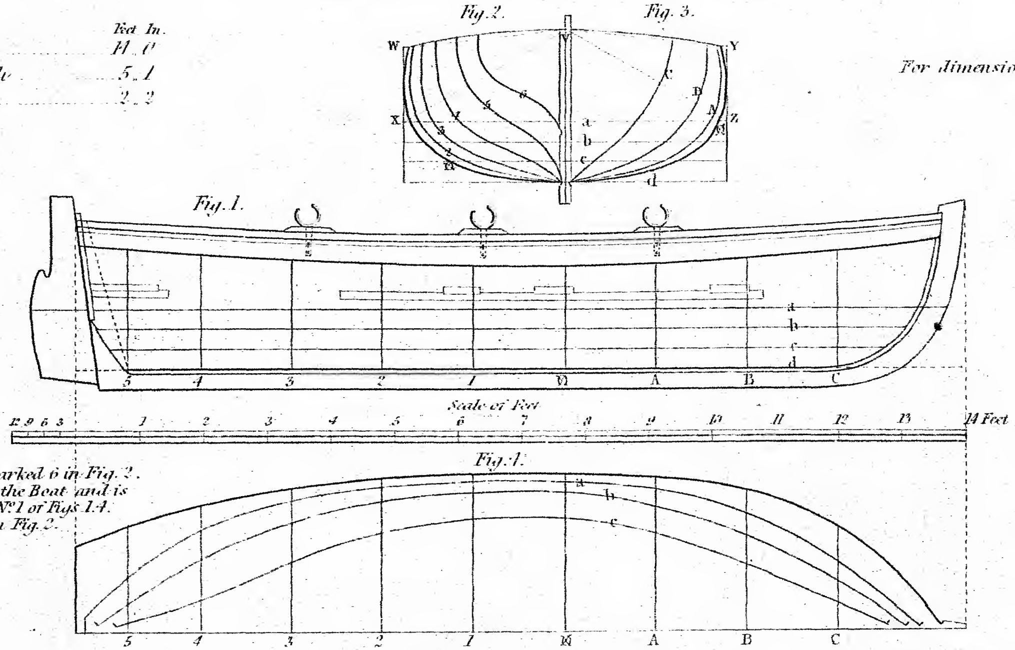
John Weale, 59, High Holborn, 1844.



DRAWING OF A DINGY OF 14 FEET.

	Feet	In.
Length	14	0
Breadth	5	1
Depth	2	2

For dimensions, see Table.



NB. The Curve marked 6 in Fig. 2. is the Stern of the Boat and is not a Section. No. 1 of Figs. 1. 4. is not given in Fig. 2.

J. W. Lowry fc.

John Weale, 59, High Holborn, 1844.

Note. — It has been found convenient to cut a perfect boat (conformable with Plate III.) in two, athwart, dividing the length nearly into two equal parts,—for the purpose of conveying them more easily over difficult roads, or from one lake or river to another. The ends are closed by a partition to each part, and are fitted with eyes, through which a bolt or iron bar is dropped. When the two halves are thus joined, they make an excellent boat; and when separate, not a bad dingy.—*Editors.*

BOMBARDMENT.*—"It may be useful to consider the nature and efficiency of bombarding towns, and also the proper employment and real value of mortars in the attack of fortresses.

"To bombard a town is merely to shower down upon it shells, carcasses, rockets, hot shot, and other incendiary missiles, to burn or destroy the buildings, and kill the inhabitants, leaving the fortifications untouched. In a well-constructed place, the military experience few casualties under a bombardment; they, as well as the powder and store, being lodged in buildings by their construction proof against the effects of missiles; and consequently both the garrison and defences are nearly as efficient at the conclusion as at the commencement of a bombardment. Being so, it is apparent such mode of attack can never succeed, except against a very small place, where bomb-proof cover cannot be obtained; or where the Governor is a weak man, whose sense of duty yields to his feelings of humanity; or that his garrison be insufficient to keep the inhabitants in subjection, under the miseries inflicted on them. The first was the case at Bourbon, where want of shelter, and the apprehension of the principal powder magazine not being fully bomb-proof, were alleged by the Governor as the causes of his capitulating. The two latter apply in their full force to Copenhagen, and at Flushing the attack was latterly prosecuted in the manner of a siege, and the Governor capitulated on account of a breach having been nearly formed in the face of the left bastion; so that casual circumstances alone gave effect to the bombardment at those places.

"To reduce a place by a regular siege is, in other words, to direct every effort against the fortifications, the garrison, and the armament, leaving the inhabitants and the buildings unmolested. This mode of attack is certain in its effects, but requires that the Engineers should be provided with considerable assistance; whereas bombardment is an operation of no Engineer science, and might be carried into effect by the Artillery Officers without Engineers, nearly as well as with them.

"That bombardment is not availing against a Governor who is firm, innumerable examples might be cited; but suffice three well-known facts.

"In 1757, Frederick of Prussia bombarded the large and populous city of Prague for twenty-two days, in such a furious manner that the town was nearly destroyed, and the inhabitants suffered so severely that they rose in general rebellion, and attempted to force the Governor to surrender; but he remained steady to his duty, hung two of the principal Senators, and by his firmness gave opportunity for the battle of Kollin, which obliged the King to retire from before the place. In 1793, equal firmness was shewn by the Dutch Governor of Williamstadt, under a furious bombardment; and the French, having trusted to mortars alone to reduce the place, failed in the attempt. The third is that of Gibraltar, which was bombarded for two years previously to the attack of the junk ships, in 1782; but who ever heard General

* This article consists of detached extracts from the Notes of the work on Sieges by the late Major-General Sir John T. Jones, R. E.

Eliot allude to the sufferings of his garrison from the enemy's shells as a sufficient cause for even thinking of a surrender.

"A strong objection to bombardment as a general system is the difficulty of effecting it at a distance from the sea, or the dépôts of a state. Some idea of the great quantity of carriage required to keep up a bombardment for a considerable time, say 100 days (the town of Landau, with scarcely a bomb-proof in it, resisted a violent bombardment for 80 days; and the little fort of Andaye for 68 days; and therefore a large place with casemates may be supposed capable of almost an indefinite resistance), may be formed from the facts, that in 1759, Admiral Rodney threw into Havre-de-Grace 19,000 heavy shells and 1150 carcasses, in 52 hours, to destroy a few boats; that in 1792, the Duke of Saxe Teschen threw into Lille, in 140 hours, without effect, 30,000 hot shot and 6000 shells; that in 1795, Pichegru threw 3000 shells into Manheim in 16 hours, and 5000 shells into the Fort of the Rhine; and at Copenhagen, in 1807, in 3 days of a partial heavy firing, 6412 shells and 4966 shot were expended, besides carcasses; and at Flushing, in 36 hours, the land batteries, and gun and mortar boats, threw about 8000 shot and 4000 shells into the devoted town, besides 5000 shot thrown into it by the fleet.

"On the score of humanity, such a system of attack should be avoided wherever possible. The cruelty of it is inconceivable to those who have not witnessed its effects, which fall chiefly on the aged, the infirm, and the helpless; and it is surely unworthy of a powerful people to seek for success by the destruction of private property, and the mutilation of women and children, when they might command it by a scientific proceeding, harmless to all but those in arms.* It may therefore be useful to make some observations on its employment in the mode most likely to render it efficient which is considered to be an auxiliary to the regular attack.

"In that character, bombardment can never be otherwise than extremely serviceable; and now that it is fully understood how much the sure and speedy reduction of a fortified place depends on the quantity of ordnance employed in the attack, and how very much the expenditure of ammunition has increased with the strength of guns and mortars, expeditions will be very differently provided from those sent out during the late war; and instead of armies being accompanied with an inadequate battering train, and inadequate ammunition for any species of attack, it is likely Officers in command will request, and the Government willingly furnish, sufficient supplies for both Bombardment and a regular Siege.

"Bombardment might go hand-in-hand with the regular attack. The mortar batteries might be established at distances from 1500 to 1800 yards from the place, to open at the same time as those of the first parallel, and fire over the workmen carrying forward the regular attack. If their fire succeed in inducing the Governor to surrender on the 4th or 5th day of the attack, a most important advantage will have been gained; but if the bombardment fail of terrifying the garrison into submission, the army will be equally or perhaps farther advanced in their operations for forcing into the place, than if no bombardment had been attempted.

"This double operation might be effected without any proportionate increase of labour to the troops, as the works of the regular attack being only 500 or 600 yards

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* After the surrender of Ath, in 1745, in consequence of a furious bombardment from Marshal Saxe, it was urged against the Governor, on his trial, and admitted by him, that only fourteen of his garrison had been killed.

As the slaughter of the inhabitants, and the desolation of the place, are described by eye-witnesses as having been dreadful to behold, some judgment may be formed from this statement of the usually comparative suffering of the soldier and citizen under a bombardment.

from the place, would naturally engross the attention of the garrison, and the mortar batteries, in their more distant situations of 1500 or 1800 yards, would probably escape observation, or at all events be considered of such minor importance as to be little molested by fire, and might be erected by the peasantry.

"It is, however, to be most particularly understood, that the means of bombardment must not detract from the means for the regular attack, nor those of the latter diminish the means of bombardment. There must be no mixture of the operations; each must be kept perfectly distinct.

"Far better will it prove to give the preference to either, and make it powerfully efficient, than to make two weak efforts. Success from either should only be expected from its own full powers to command it.

"A regular attack may, in some degree, be abridged by the skill or boldness of a Commander; but the success of a bombardment depends altogether upon its own efforts being powerful, unceasing, and maintained in their greatest fury till the proposed effect be produced.

"To bombard a considerable place in a manner really efficient, at least 60 mortars or howitzers should be put in battery, and it would be better that the number were 100. They should fire without intermission throughout the day and night; and, with that view, be furnished with at least 200 rounds each per day. Any increased number of mortars used at a bombardment would not necessarily increase the expenditure of ammunition, as a certain number of rounds fired in three days from 100 mortars is infinitely more likely to terrify a Governor and population into submission, than the same number of rounds fired in six days from 50 pieces."

VALUE OF MORTARS AT A SIEGE.

"As instruments to be used in furtherance of the regular attack, mortars are, however, highly useful, and in some cases indispensably necessary; particularly to search behind and knock down the defensive traverses; to drive the garrison out of their retrenchments, and carry destruction and disorder through every portion of their interior defensive expedients; to tease and harass the guards and tirailleurs, burn the barracks, storehouses, and dépôts of provisions; tear up bridges, break down dams and sluices, explode expense magazines, and annihilate many earthen defences, not to be affected by shot. As weapons of personal annoyance, they are also of great use by their vertical fire, both great and small; for instance, in a confined advanced work, shells from a few mortars will, besides destroying the defences, cause innumerable casualties, if it be kept fully garrisoned; or, if to avoid loss, the enemy keep but few men in it, the work becomes open to assault.

"A few pierriers and mortars, at the siege of Badajos in 1812, would have had such an effect on the Picurina redoubt; and heavy shells would readily have destroyed the dam of the inundation, and dislodged the defenders from the bridge. Indeed, to attempt to carry on a siege without the aid of mortars, can only be compared to a man volunteering to fight a formidable antagonist with one arm tied up.

"At a regular siege, as well as at every other attack, a judicious mixture of the several natures of ordnance seems to be the proper medium. The proportions of each must vary according to the nature of the attack; but, when battering trains are fitted out without a precise object, it would seem advisable to have one mortar or howitzer with every four guns in large trains, and one mortar with every three guns in small trains, adding one pierrier to every three mortars. It is, however, submitted to the Artillery Officers, if it would not be still better that a proportion of one-pound or half-pound balls should be added to their siege ammunition, in which case mortars of every diameter would be available as pierriers."

STRENGTH OF ARCHES.

"The strength of masonry is far greater in southern than in northern climates;* whilst the concussion produced by the fall of shells, at equal distances, and of equal weights, must be the same in all climates and in all ages: why, therefore, do arches of magazines give way more frequently now than in former wars? It can only be accounted for from the fact, that in the proportion that one shell was fired into a place in those days, we, in our bombardments, throw fifty into a place. Substance is now required much beyond that essential for strength. It is not sufficient that an arch have all the requisite proportions to resist the shock of the heaviest shell, and the piers a force to bear it up, or the roof a pitch to keep it dry; it must also have bulk over it, to admit of the repeated abstractions of substance, caused by numerous shells striking it in rapid succession. Each shell blows away a portion of the covering of the arch, and if their fall be so continuous as to prevent fresh covering being laid on, they speedily penetrate to the masonry; after which each shell carries away 2 or 3 inches thickness of the brick-work, and in a few rounds the equilibrium of strength of the arch is destroyed. As soon as that is effected, a shell striking any part of the surface shakes the arch through and through, and after a time it is shaken down.†

"That a bomb-proof arch should be kept extremely well covered is therefore fully as important to its resistance, as that sufficient dimensions be given to the arch itself. Officers in future must take precautions against the increased use of artillery of the present day, and no longer trust to dimensions derived from the experience of the wars of Louis XIV. *In small places, like Fort Bourbon, no magazine should have less than* 8 *or* 10 *feet of masonry and earth over its arch;* and every Governor, during a bombardment, ought most sedulously to enforce the immediate restoration of every portion of earth blown away by the fall of shells."

BOOM.—The consideration of this subject becomes important from the increased necessity of guarding against the sudden attacks of steamers, upon rivers and harbours, especially at remote points.

Booms may be applied either to bar access to a harbour or river, or to cut off the retreat of the enemy, should the entrance have been effected by surprise.

Like Abattis, Palisading, &c., before field-works, Booms should never be left unprotected, and should be immediately under fire of a battery or of a man-of-war, and its guard-boats on the look-out.

It is conceived that the most effectual check to a ship's progress would be given by the partially elastic opposition of hemp cable booms; but as these are liable to be quickly destroyed,‡ those of chain, floated by logs, and moored as occasion requires, seem to be most advisable, at least for the exterior line, reserving hemp, if admissible, for those in rear. It is unsafe to trust to a single line of boom in the main channel: a chance or a well-directed shot, or the impetus of the vessel in unusually strong

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* The author once had in his possession a memorandum made on the spot by an Officer, that an arch of 18 feet span and 2 feet 9 inches thick, without any covering, resisted two shocks of 13-inch shells successively, at the siege of Fort George, in Minorca.

† A heavy shell, falling on a bomb-proof arch well covered with earth, has been known to cause such a concussion as to make wine-glasses jump off a dinner-table in a casemate, without injury to the arch.

‡ 'A carpenter's mate—a hand saw and a lump of grease,'—formed a standing part in arrangements for cutting out vessels in the late war, when hemp cables were commoner than those of chain.

winds and tides, &c., &c., may defeat the best calculations of sufficient strength; but, with the check received from the first, if at all adequate to its duty, it would be scarcely likely for any vessel to have way enough to break a second, or at most a third, which should be placed at short distances, say from 50 to 100 yards apart in rear,—or perhaps only sufficient for two large boats to row past each other freely.

Even when there is no perceptible rise and fall of tide, a boom must not be strained too tightly, as a 'passive resistance' of the dead weight of the slack portion would be lost. On the other hand, if too loose, the vessel will easily pass over it.

Generally speaking, the allowance necessary for the rise and fall of tide will give sufficient play. In figs. 1, 2, where a length of boom of about 300 yards has been assumed, and where, as in figs. 3, 4, 5, there may be a rise and fall of 18 feet in a depth of 100 feet, there will be upwards of 50 or 55 feet between the extreme positions of the boom at ebb *a*, *a*, and young flood *b*, *b*.

Booms need not necessarily extend entirely across an entrance; shallow or otherwise inaccessible parts may be omitted, or else blocked up by much lighter chains than are necessary for the main channel. A trifle will keep out a gun-boat,—not so a first-rate or a large steamer. A boom may be kept constantly down, in whole or in part, as the urgency of the case requires. Not to impede the navigation unnecessarily, the 100 yards over that part which will be deep enough for vessels entitled to enter can be withdrawn to either side entire; or to both, in halves, ready to be replaced, *d*, figs. 1, 2.

To give perfect facility for throwing a boom across at any moment, an express establishment will be necessary, according to the extent of the obstacle, of—

1. A party familiar with the operation.
2. Housing for these; and for stores when not immediately wanted.
3. Protection for both—afloat and ashore, including guard-boats.
4. Moorings;—a distinct charge from the above, generally devolving on Harbour-Masters.

The first three will be disposed of at once, if a man-of-war be specially assigned to this duty; or, at all events, a hulk, not only armed, but fitted with the common arrangements of timber ships, or breakwater vessels, for readily passing out the logs, chain, &c., &c. If anchored near the opening, it would probably afford all the protection that could be required, as well as many facilities for general harbour duties, and the Police and Revenue Services. The timber can either be rafted, moored, and left afloat, or else stowed away below. This sort of provision is the least expensive, so much being left available when no longer required for this service. It is best suited for the defence of small ports. But, if from the importance of the harbour or river, or other causes, an establishment must be made ashore, it will probably amount to a small barrack, store-sheds to receive the boom, boat-house, battery and appointments complete, and perhaps a small floating dock, or a pier, should it be necessary to keep the boom afloat and in readiness.

The moorings, at perhaps 100 yards laterally apart, will have nothing peculiar: the buoys must be solid, as in a dark or misty night they are easily scuttled as usually built; the boom must be quite independent of these last as to buoyancy.

DETAILS OF CONSTRUCTION FOR CHAIN BOOMS.

It is here assumed that it is to be a continuous chain, supported by wooden floats of sufficient buoyancy to offer some resistance to the whole being readily submerged; and of such a shape as shall not expose a flat surface abruptly to the waves.

The cheapest materials will be condemned masts and the larger yards and spars of men-of-war, cut into suitable lengths, as short as may be convenient, and with inter-

vals not exceeding 3 feet; so that should any one piece be carried away, no very large chasm may be made by the drooping of the unsupported part. The chain should be attached to these junks of masts by *very* strong staples, well secured, alternating with small chain lashings; for if this be at all feebly done, it will be a weak point at which the very shock may destroy all, without a single thing being broken or disturbed, except the staples or other fastenings being started.—(See fig. 7.)

When a Boom is to be a permanent affair, and no old masts are to be had, it may be advisable to build solid cylindrical floats, well hooped, of the required dimensions, just as masts are constructed.

When of a temporary character, and the sacrifice of material is to be avoided, square baulks, lashed together with chain, instead of being hooped, may be substituted for the above.—(See fig. 9.)

In estimating the shock to be expected, it must be remembered that sailing vessels are not now likely to run into such a cul-de-sac as a harbour, though they may venture through a river or a strait, with open sea at both ends. Hence in the present day we must calculate as for steamers. Our largest men-of-war of this description may be taken at 1000 or 1200 tons burthen; and this, with a velocity of perhaps 15 knots, would snap any *chain cable*, as made at present, where the largest are only of $2\frac{1}{4}$-inch round iron; and unless the next such line be very near, it would demolish that readily, as a steamer recovers way, even if entirely stopped by the blow for the moment, in a manner that other vessels cannot do.

For such extreme cases, it is conceived that nothing less than the large and massive mooring chains, of at least 3-inch square iron, has a chance of success; and if the 2nd or 3rd lines are pretty close, even so large a vessel may be staggered, and embarrassed for a sufficient length of time to enable her machinery to be destroyed from the protecting batteries.

The selection of any intermediate sizes between such a boom, and that only sufficient to keep out boats or small steamers, must depend on the importance of the harbour or river, as well as on the draught of water determining the size of the steamer that can enter.

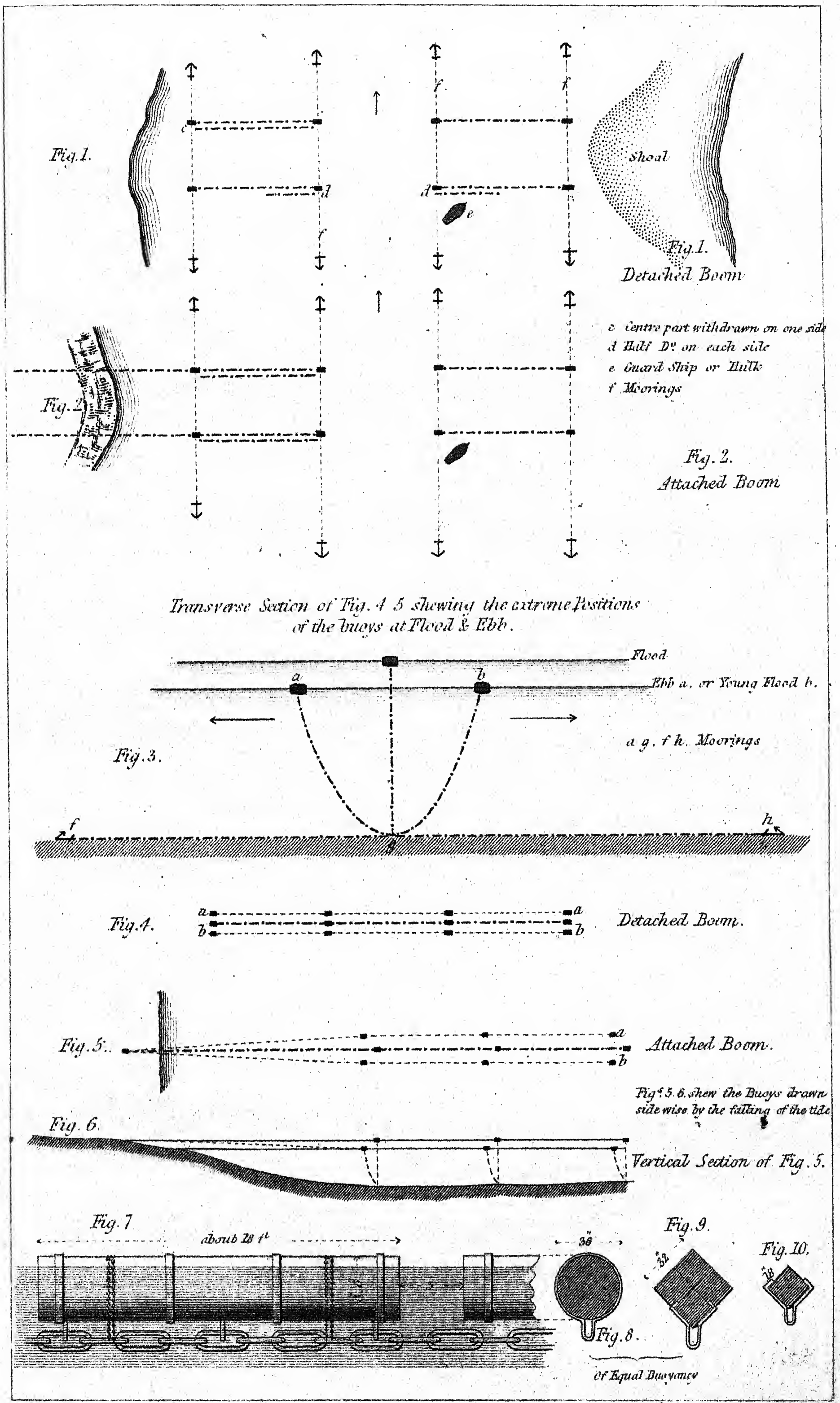
Fig. 7 shews a boom as proposed to be made out of old masts. When built expressly, the hoops and staples can be made in one (fig. 8). To support a mooring chain of 2′ 6″ links, 3″ square iron, properly, the diameter, if of yellow pine, ought not to be less than 36 inches.

If the square form be decided on, a side of 32 inches will be required (fig. 9); the lower baulk alone need have staples or clamps. The chain used as lashing will do no injury to the wood, and any degree of tightness and compactness can be given by means of wedges.

Fig. 10 is a baulk siding, 18 inches, as necessary for the largest class *chain cable* made at present.

Booms for small rivers, to protect pontoon bridges, &c., or to obstruct navigation, are easily made on the above principles, except that, should the vessels on the river be of light draught only, and no serious attack be apprehended, logs of wood, connected by short chains, and couplings well let in and secured, will probably be sufficient. Whether the boom is to go directly across the stream, or to do so obliquely, so as to reduce the strain, will be determined by localities and the strength of the materials available.

A line of palisading is sometimes used to close a river. It is rarely advisable, and very expensive, especially if only for temporary purposes; for if it be mere palisading in bays, hanging on ribands, it can be easily cut through in the night; but if the main posts or piles be at all near enough to prevent boats from passing, they will, in



R. J. N. del. J. W. Lowry fc.

John Weale, 59, High Holborn. 1845.

most cases, and in no great length of time, by accumulating mud, sand, &c., form impediments to navigation not readily removable.

HEMP CABLE BOOMS.

The buoys, moorings, and general arrangements remaining as before, the slight assistance necessary to support the cable will be best given by spars of moderate scantling, which add to the strength in a way that is not done by casks or small buoys. When from necessity casks—always liable to damage—are used, care must be taken not to expose their ends to the sea, or they will soon be destroyed.

R. J. N.

BREACH, as effected by Artillery.—No precise rule can be given either as to the time or ammunition required to make a Breach. The best precedents within reach are therefore given, leaving their application to circumstances.

The two most recent and complete examples are those given by the French experiments at Metz, 1834; and in their siege of Antwerp in 1832. They differ considerably; chiefly, perhaps, from the latter having been conducted under fire, and the former, (like our experiments against Carnot's Wall,) at leisure and undisturbed; especially as they were made against a fine specimen of Vauban's masonry, which could scarcely have been surpassed by anything at Antwerp.

	Guns.	Width of Breach. feet.	Shot and Shell.	Distance. yards.	Total Time. hours.
Antwerp	6 24-prs.	80	1288	55	34
Metz	4 24-prs.	72	256*	35	8†
	4 16-prs.	75	325*	33	9½†

The best representation of the variable effects of Breaching Batteries is given by Capt. Sir Wm. Denison, in vol. ii. p. 38, Corps Papers.

	Width of Breach. feet.	No. Shot.	Distance. yards.	
1812.—Christoval	15	1,600	450	
Badajos, main breach	180	14,000	540	
,, flank ditto	100	9,500	530	Wall casemated.
,, curtain ditto	40	3,000	545	Bad masonry.
Ciudad Rodrigo, main ditto	105	6,700	560	
,, lesser ditto	30	2,080	570	Bad masonry.
1813.—St. Sebastian.				
main breach	100	13,000	620‡	Good masonry.
lesser ditto	30	5,000	620‡	Ditto.
addition to breaches	330	41,000	520‡	Ditto.
	930	95,880	4955	

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* Including forty 8-inch shells to each breach.

† Total time, including that probably required for exchanging guns for howitzers.

‡ Average distances. The quality of the masonry from a R. E. Officer engaged in the siege.

Hence, and from the preceding, as well as from the 'Observations' of Major-General Sir J. May, R.A.—

	Average No. Guns.	Total Width of Breaches.	Mean Distance of Batteries.	Time.	No. Shot per running ft. of Breach.	
		feet.	yards.	hours.		
Badajos	26	320	540	104	83	Brass and Iron Guns. } Bad masonry.
Ciudad Rodrigo . . .	28	135	565	$32\frac{1}{2}$	65	Chiefly Brass. } Bad masonry.
St. Sebastian* . . .	20	130	620	62	139	Iron Guns. Good masonry.
These, proportioned to 10 guns and 100 feet of breach, become—for						
LONG RANGES.						
Badajos	10	100	540	85		
Ciudad Rodrigo . . .	10	100	565	$67\frac{1}{2}$		
St. Sebastian . . .	10	100	620	$95\frac{1}{2}$		
A. General average . . .	10	100	575	83	92	
SHORT RANGES.						
B. Antwerp	6	80	55	34	16	Brass Guns. } Good masonry.
C. Metz (average) . . .	4	74	34	$8\frac{3}{4}$	4	Brass Guns. } Good masonry.

Here we have, probably, two extremes (A, C,) and a mean (B) of practice. The Peninsular cases were effected under many disadvantages; the Metz experiments under none; the Antwerp Breach under almost normal circumstances, and gives what may be fairly expected, in short ranges, on Service: it corroborates also the judgment of Bousmard, who specifies about 36 hours † as the time necessary. Where the rubbish cannot be well cleared away from the breach, as in wet ditches, and other cases, the horizontal groove may be cut at one-third or one-half height of escarp from the bottom; it being remembered that such sized débris gains about two-thirds in bulk from being reduced to that shape from the solid form. But, if it can be removed, the groove should not be more than 3 or 4 feet above the ditch, to insure a readily practicable breach.

The experience at St. Sebastian in 1813 is opposed to the conclusion from the Metz experiment, that firing by salvos is virtually impracticable: it was done at that siege, even by the ship guns in battery, to all practical purposes; and if detonating locks be used, there remains no doubt on the subject.

Capt. Sir Wm. Denison observes, at the end of his Paper referring to the Peninsular Sieges,—the Woolwich experiments on Carnot's Wall, and those at Metz,—"From the

* Referring only to the 'Main' and 'Lesser' Breach:—the 'addition to the Breaches' is rather too vague for even this sort of computation.

† When the old French writers speak of four days to form a Breach, it must have been with brass guns, which, at that time, could hardly be fired oftener than four rounds per hour,—even to the opening of the Revolution, when the attention of the Government was first drawn to that subject. The disparity of power between large and small brass guns, as to standing rapid and long-sustained firing, is very remarkable.

At Ciudad Rodrigo and Badajos, 13 rounds per hour were averaged with brass guns. At Metz, 12 per hour. At St. Sebastian, with iron, 20 per hour. Hence Bousmard's 36 would probably be 26 with iron guns.

foregoing it appears, that a breach about 100 feet wide may be rendered practicable at a distance of 500 yards by the expenditure of about 10,600 24-lb. shot, firing at full charges; that from about the same distance it requires 5600 68-lb. shot, and 4200 8 and 10-inch shells, à ricochet, to make a breach of the same width when the scarp is covered by a counter-guard, as proposed by Carnot; and that from a battery on the crest of the glacis, about 310 24-lb. shot, and 30 to 40 8-inch shells, will produce the same effect. The weight of shot, therefore, expended in forming a breach under these different circumstances will be as follows:

	Width of Breach. feet.	Distance. yards.	Fire.	No. Shot.	No. Shells.	Total weight of Iron. lbs.
Peninsula .	100	500	Direct.	10,600	—	254,400
Carnot . .	100	500	Ricochet.	5,600	4,200	660,100
Metz . .	74	50	Direct.	310	40	9,040

"The disproportion between the direct and ricochet fire would have been more glaring still had guns of the same calibre been used on both occasions; for the effect of one 68-lb. shot would be far greater than that of three 24-lb. shot, fired at the same angle; and the 8 and 10-inch shells used in the ricochet practice were probably more effective than shot of the same weight."

To effect a breach by mining in a masonry revetment occasions an expenditure of time and labour not always rewarded by a good practicable breach, as the explosion generally brings down the escarp in masses difficult to scramble over. This mode of procedure must depend on questions of locality, time, and means, and the facility of attaching the Miner. In earthen ramparts, mud walls, and walls as usually constructed in the East, it is in many cases the only practicable method of making a breach.

R. J. N.

BRIDGE, PERMANENT. *See* 'Passage of Rivers.'

BRIDGE, FIELD.—Blanshard's Cavalry and Infantry Bridges;—Boat;—Rope;—Boat and Rope;—Cask;—Trestle;—Raft;—Pile and Spar;—Flying, Pivot;—Flying, Trail;—Reconstruction and Demolition.—(See Plates I. to XVIII.)

It is on the above that memoranda are presumed to be most acceptable, omitting many minor contrivances alluded to in foreign works, which circumstances of time and place would suggest to very ordinary ingenuity: as it is, the above series includes even Ferries.

Whatever Bridge system may be under consideration, either for introduction into the Service or for selection in the Field, the following will be amongst the guiding points in determination.

General applicability. { If available as rafts, boats, &c., besides serving as a bridge.

Simplicity of character. { So that its management may be easily learned by all troops.

Capability of rapid construction.

Security from destruction by the enemy.	From peculiarity of construction in detail, or from its general arrangement.
Ultimate buoyancy.	
Stability.	
Height of superstructure above water.	As illustrated below,* with regard to the most probable elementar, forms proposed for buoyant bodies.
Ease of management and motion on water.	Implying also lightness, and suitability for speed in rowing as a raft, boat, &c.; capability of movement as a quadrant of conversion.
Facility of detail, construction, and repair.	As requiring only such material and workmanship as may most likely to be at hand.
Security from destruction by natural causes.	Strength to oppose the violent action of wind or water, little liability to split or warp from heat or ice; or to spoil in store, or in use, by the general action of heat, moisture, or by vermin, &c.
Cost and current expenses.	

BRIDGE, PONTOON;† RAFTS, GENERAL EQUIPMENT, &c.

Pontoons are hollow cylindrical vessels of tin, which, being perfectly water-tight, possess from their shape great buoyancy, and are used for forming bridges for the passage of rivers by armies in the field.— See Plates I. to VI.

A pontoon consists of a cylinder 19 feet 6 inches in length by 2 feet 8 inches in diameter, with parabolic ends, each 2 feet 6 inches long; the total length of a pontoon is consequently 24 feet 6 inches.

Pontoons are usually formed of sheet tin, of the description and quality known in the trade as × × ×, framed round a series of light wheels constructed of tin, having hollow tubes of 1 inch diameter for the spokes; the axis, a hollow tin cylinder $1\frac{3}{4}$ inch diameter, running through the entire length of the pontoon.

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* The following Table gives nearly the relative heights remaining above water of the Square, the Circle, and Equil. Triangle, of equal areas on submersion to $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$ of their buoyancies; the two last figures giving (with reference to probable forms) the extremes of greatest and least area in relation to periphery.

	A Square.	B Circle.	C Equil. Triangle on its base.	D Equil. Triangle on its vertex.
Buoyancy reduced to $\frac{1}{2}$ . .	50	57	93	39
" $\frac{2}{3}$ . .	33	42	76	24
" $\frac{3}{4}$ . .	25	34	66	18

Hence, could stability be given to C, it would *in this respect* be the best; then B; then A; and D, the worst.

† *Royal Engineer Establishment, Chatham, 25th June*, 1852.

It having become necessary to reprint the Pontoon Exercise, some trifling alterations will be found which are more in form than in details.

As it is very desirable to simplify the drill as much as possible, the detachments attached to the carriages have been regulated in such a manner, that when the pontoons and stores are unpacked ready for forming a bridge, the same detachment should form the crew of the raft carried on the carriage to which they had been originally told off.

The exercise is divided into two parts, 'Packing and unpacking the Carriages,' and 'Forming a Bridge,' which can thus be practised separately.

Those Officers who have had experience in marching with a pontoon train are well aware of the great importance of having every thing on a carriage properly and securely packed, in order that no

The pontoon is internally divided into nine distinct compartments, perfectly water-tight and independent of each other. It is provided with four rows of sunken handles, placed at intervals of 2′ 1″ round the circumference, for the purpose of lashing the saddles which are placed on it, and form the bearing of the baulks which support the superstructure of the bridge; each end has a stout iron ring securely attached to it.

Single Raft.—*Two pontoons*, with their allotted superstructure and stores, form a single raft.

Double Raft.—*Two single rafts*, connected together, form a double raft, on which heavy artillery can be conveyed across a river.

Pontoon Bridges are formed by the connection of rafts in sufficient number to reach across rivers of moderate width, and are connected with the banks by means of temporary stages or landing-places.

A Pontoon Bridge, so formed, is capable (under several modifications of structure) of sustaining the passage of heavy artillery and stores, and troops of all arms of the Service.

The Saddle of a pontoon is a framing of fir, 12 feet in length, 1 foot 2 inches in breadth, and 3 inches in depth, which is placed lengthwise on the centre of the pontoon, and secured to it by lashings, to receive the ends of the baulks extending from pontoon to pontoon.

Baulks are likewise of fir timber, 14′ 2″ in length, $4\frac{1}{2}$″ in depth, and 3″ in breadth, placed in position from saddle to saddle, and being secured to them by means of iron pins or bolts, form the supports of the flooring of the bridge or raft.

Whole Chesses, which form the floor of the bridge, consist of three fir planks, connected together by four cleats on the under side, and are 11′ 5″ in length, 2′ 1″ in breadth, and $1\frac{1}{2}$″ in depth.

Half Chesses consist of a single plank 11′ 5″ in length, 1′ $0\frac{1}{2}$″ in breadth, and $1\frac{1}{2}$″ in depth, strengthened by cleats in a similar manner to the whole chesses, and are placed over the saddles in order to afford ready access to the pins, &c.

Each raft is furnished with 2 saddles, 12 baulks, 10 whole chesses, 4 half chesses, 1 anchor and cable, 6 oars for rowing and 1 oar for steering, 1 buoy line and 1 breast line, 1 boat-hook, and a proportionate number of lashings.

A Pontoon Carriage is a four-wheeled carriage with a perch, and bolsters over the axle-trees, and is capable of carrying a raft and its stores.

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interruption to the march and consequent delay to a whole column may arise from the necessity of making a halt to repack any of the stores which may have become deranged by the motion of the carriage.

To the proper packing of a carriage the greatest attention therefore is required from the Officers and Non-Commissioned Officers attached to a pontoon train, who ought personally to inspect the several lashings of each carriage every morning before moving, in order to ascertain that everything is secure and in its proper place: inattention to these particulars may occasion great delay and retard the movements of columns of troops which may be moving on the same line of road, but in rear of the pontoon train, and the pontoons may fail to reach the spot where a bridge is to be formed at the appointed time.

The word 'Port' having been adopted in the Royal Navy instead of the word 'Larboard,' the same rule is now observed in the Pontoon Exercise, and the word 'Larboard' will be found omitted.

Harry D. Jones,
Colonel, Royal Engineers, Director.

Table of Stores carried on a Pontoon Carriage.

	No.	Dimensions.			Weight.		
		Length.	Breadth.	Depth.	cwt.	qrs.	lbs.
		ft. in.	ft. in.	ft. in.			
Pontoons	2	24 6	2 8	2 8	10	0	10
Baulks	12	14 2	0 4½	0 3	5	1	22
Chesses	10	11 5	2 1	0 1½	8	2	18
Half Chesses . .	4	11 5	1 0½	0 1½	1	1	16
Saddles	2	12 0	1 2	0 3	1	1	27
		Shank.	Flukes.	to Flukes.			
Anchor	1	3 10	2 0	0 1	..	1	27
Buoy	1	2 0	0 10	0 10	..	..	5¼
Cable, 30-fathom .	1	180 0	0 3	Rope.	..	2	7
Oars	7	14 0	..	..	..	3	24¾
Boat-hook . . .	1	16 0	..	..	..	..	9
Body Lashings . .	3	8 9	0 4	Webbing.	..	..	20
Saddle Lashings .	4	15 0	0 1	Rope.	..	..	5
Carriage Lashings .	4	22 0	0 1	Rope.	..	..	7
*Rack Lashings .	8	6 0	0 2	Rope.	..	..	5
*Rack Sticks . .	8	1 0	0 1½	0 1½	..	..	5
*Buoy Line . . .	1	60 0	0 1	Rope.	..	..	5
*Breast Line . .	2	60 0	0 1	Rope.	..	..	10
*Outriggers . . .	2	11 5	0 4½	0 3	..	2	20
Carriage Weighs .	..	..	..	..	13	3	20
Total Weight . .	. . .	. . .	. . .	. . .	44	1	11

The baulks are the first stores packed; these are placed on the centre of the bolsters, which are cut to receive them, so that when laid in their proper places the tops of the baulks and the bolsters are level; the chesses are placed immediately over them, the two saddles are laid over the chesses, and the cable stowed between the saddles; the two pontoons are then placed on the saddles, the oars being packed over the cable between the under-side of the pontoons; the anchor and buoy are securely lashed to the perch of the carriage.

The pontoons and stores are secured to the carriage by webbed girths which are passed over the pontoons and lashed down to the carriage.

DETACHMENTS FOR PONTOON CARRIAGES.

The men belonging to the pontoon train are told off in detachments of 6 men, (with a Non-Commissioned Officer where one can be spared,) and each detachment of 6 has charge of a carriage with its pontoon and stores.

The Officers are distributed by the Commanding Officer according to their number amongst the different carriages.

The carriages are numbered from right to left.

The stores being laid out on the ground, and the men drawn up in line in rear of the carriages, the following instructions detail the mode to be adopted.

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* These are packed in the carriage-box, not being used until the bridge is formed.

TO PACK THE CARRIAGE.

WORDS OF COMMAND.	
Numbers by Threes from the Right.	The front rank men are the left section, and the rear rank the right section.
Threes, Left Wheel, Quick March. Halt. Dress.	
Non-Commissioned Officers number Detachments from front to rear.	The men will then be proved, until each Non-Commissioned Officer and private knows his number, and how they are told off.
Form up on your respective Carriages, Right face, quick march.	The detachment will be marched right in front along the rear, and will be halted in succession behind their respective carriages.

No. 1, Right Section, halts in line with the off fore-wheel.
„ 2, „ „ covers him between the wheels.
„ 3, „ „ do. 1 and 2, in line with the off hind-wheel.
„ 1, Left Section, halts in line with the near fore-wheel.
„ 2, „ „ covers him between the wheels.
„ 3, „ „ do. 1 and 2, in line with the near hind-wheel.

Prepare to pack the Carriages.

Collect Stores. The Right Section lays out . . . . 1 Pontoon, 1 Saddle, 5 Chesses, 2 Half Chesses, 6 Baulks, 4 Oars, 2 Outriggers, 1 Cable, 1 Anchor, 1 Buoy — To the right side of the carriage.

and

The Left Section lays out . . . . 1 Pontoon, 1 Saddle, 5 Chesses, 2 Half Chesses, 6 Baulks, 3 Oars, 1 Boat-hook — To the left side of the carriage.

They will also collect the following small stores and lashings, and place them in the box, in the front of the carriage, viz.

3 Body Lashings
8 Rack Lashings and Sticks
4 Pins
1 Breast Line
1 Buoy Line
4 Saddle Lashings
4 Carriage Lashings.

The greatest care possible must be taken by the Non-Commissioned Officer in charge that the above small stores have been duly collected and placed in the box; in the dark, men are in the habit of placing them on the ground, where they are liable to be lost. The Detachment will then fall in at their respective places on each side of the carriage.

Pack the Carriage.

Baulks. At the word '*Baulks,*' No. 1 right section will place himself at the front, and 3 left section at the rear of the carriage, ready to pack the stores, which the other four men from their respective sides of the carriage will hand to them.

Four baulks are placed flat on the bolsters of the carriage, the other eight baulks are placed edgeways on the former, and are bolted and keyed to the fore bolster.

Chesses. At the word '*Chesses,*' No. 1 right and No. 3 left section pack them, the other four men lift them on the carriage.

Care must be taken that the first chesses are laid ledges uppermost, and flush with the front end of the baulks. The next chess is laid ledges downwards, and retired sufficiently for the ledges to be clear of each other, and so on alternately.

Saddles. At the word '*Saddles,*' the left detachment bring up one saddle and the right detachment the other, placing the cleats downwards, the pins outwards, and within one inch of the outer edges of the chesses.

Lash down Saddles. Nos. 1 lash the saddles to the fore bolster, and Nos. 3 to the hind bolster of the carriage; the lashings are made fast to the inner rings on the bolsters in front of the fore bolster, and a turn taken round the outside horn of the belaying cleats of the saddle; they are then passed through the ring and up through the hand-holes of the chesses, round the inner horn of the belaying cleats, and again down through the hand-holes of the chesses at the rear of the carriage, but outside of them in the front, then again through the rings, and are fastened by a frapping turn. Whilst Nos. 1 and 3 are thus employed, Nos. 2 lash the anchor and buoy to the perch of the carriage.

Outriggers and Cables. At the word '*Outriggers and Cables,*' No. 1 right and 3 left receive these stores from Nos. 2 and 3 right. Nos. 2 and 3 right then hand up the cable, which is laid on the outriggers by the two men who pack the Stores.

Prepare to place Pontoon on Carriage. Upon this caution, the whole of the detachment place themselves at equal distances on the outside of the pontoon to be placed first on the carriage. Two baulks are then withdrawn from the carriage for the purpose of rolling up the pontoon on to it, one end of each baulk resting on the superstructure which has been packed, and the other end resting upon the ground at an angle convenient for rolling the pontoon on to the carriage.

Roll Pontoon on Carriage. The pontoon is then carefully rolled up the baulks on to the saddles, and the baulks replaced on the carriage.

Lash down Pontoons. Nos. 1 will lash the head and Nos. 3 the stern of the pontoons by the handles of the pontoons to the saddles, round the back of the belaying cleats; No. 2 left will assist at the head, and No. 2 right at the stern; after which Nos. 1 and 2 will pass the oars and boat-hook between the pontoons with the blade to the rear, and Nos. 3 will lash

three oars and the boat-hook to one of the inner handles at the stern of the pontoon, and three oars to the other; great care being taken to secure the oars, to prevent them slipping off the carriage in travelling.

Pass the Body Lashings over the Pontoons. No. 2 left gets on the top of the pontoons to adjust the fenders attached to the lashings; Nos. 1 and 3 pass the front and rear, and 2 right the centre body lashing over the pontoons, and as soon as the fenders are adjusted No. 2 left goes to his place at the side of the carriage.

Make fast the Body Lashings. Nos. 1 and 3 lash their respective ends of the body lashings to the two outer rings at the side of each end of the bolster of the carriage, and Nos. 2 passing the respective ends of the centre lashing through the centre handles of the pontoons, cross the ends to each other under the baulks, and then through the triangular rings at the opposite side: the whole of the body lashings are made fast by a frapping turn.

TO UNPACK THE CARRIAGE.

Unlash and cast off the Body Lashings. Nos. 1, Nos. 2, and Nos. 3, unlash and cast off their respective ends of the body lashings. Nos. 3 then unlash the oars from the inner stern handles of the pontoons. No. 2 left gets on the top of the pontoons and disengages the fenders.

The left section then fold up the body lashings and place them in the box at the front of the carriage. They also withdraw the oars and boat-hook from between the pontoons, and place them on the left side of the carriage.

Unlash the Pontoon Lashings. Nos. 1 and 3 unlash the lashings at their respective sides and ends of the pontoons, No. 2 left section assisting at the head, and No. 2 right section at the stern. The pontoons are then rolled steadily down on two baulks placed as in packing them.

Unlash and dismount the Saddles. Nos. 1 unlash the fore lashings, and Nos. 3 the head lashings of the saddles and dismount them, placing them alongside their respective pontoons; Nos. 2 at the same time unlash the anchor and buoy, and place them on the right side of the carriage.

Dismount the Stores. No. 1 right places himself at the front, and No. 3 left at the rear of the carriage, ready to hand the stores to the right and left Nos. in the following order:

The cable and 2 outriggers to the right Nos.

5 chesses, 2 half chesses, and 6 baulks respectively, to the right and left Nos., who will place those stores on the ground on their own side of the carriage, the Non-Commissioned Officers observing that they are neatly packed.

FORMING THE BRIDGE.

In forming the bridge, the detachment of each carriage form the crew of a raft, whose number corresponds with the number of the carriage. No. 1 carriage becomes No. 1 raft, and so on.

The stores being unpacked and placed by the side of the river, the bridge is now formed by launching successive pontoons into the river and placing the superstructure on them; this is termed—

BOOMING OUT.

The pontoons should not be rolled down, but carefully carried to the edge of the water, below the position where it is intended to form the bridge, and they will be brought up to their places against the current.

THE DUTIES OF RAFT DETACHMENTS.

RAFT No. 1.—Nos. 1, cable men, who will keep the bridge in its proper position, and belay the cables to the rafts by the belaying cleats of the saddles of the pontoons opposite to the anchors, shifting them as the bridge is boomed out, and taking great care that they do not cross the cables.

*Nos. 2, SMALL STORE MEN, who take in four oars and one outrigger, on the starboard side of the bridge, and three oars, a boat-hook, and another outrigger, on the port side of the bridge; which stores are handed to them by Nos. 3 of No. 7 raft. The whole of these stores are laid across the pontoons.

Nos. 3 LAY THE CHESSES, taking care that the joint of the two half chesses are over the centre of the saddles, and flush with the belaying cleats.

RAFT No. 2.—Nos. 1 will lash the saddles on the pontoons, which must be over the centre and within three inches of the second handles from the ends of the pontoons; this lashing must pass three turns over the saddle and twice in front close to the ends of the saddle, and be made fast by a couple of half-hitches.

Nos. 2 WILL PASS THE PONTOONS, under the saddles; and Nos. 3 will haul them up to be in readiness.

RAFT No. 3.—FRONT SADDLE MEN.—Nos. 1 and Nos. 2 will pass and pack the chesses on the pontoon last inserted; Nos. 3 pin the baulks to the second saddle from the land, assisted by the baulk men.

RAFT No. 4.—BAULK MEN.—No. 1 starboard brings up the right baulk, No. 2 next baulk, No. 3 right centre baulk, No. 1 port the left baulk, No. 2 the next, No. 3 the left centre baulk, and the whole will assist in pinning the baulks to the saddles, taking care to pin the two outside baulks to the saddles before any more are placed.

RAFTS Nos. 5 and 6.—CHESS MEN.—Nos. 1 of No. 5 raft will bring up two half chesses and lay them across the baulks joining the shore bay,—Nos. 2 the first whole chess, Nos. 3 the second, Nos. 1 of No. 6 raft the third, Nos. 2 the fourth, and Nos. 3 the fifth, which must be brought in succession, and be laid in a similar manner to the two half chesses, with the wide space between the cleats towards the river. The chesses must be laid gently on the baulks.

RAFT No. 7.—Nos. 1 and 2 SADDLE MEN.—Nos. 1 will bring up the front saddle and will lay it parallel to the river, with the pins towards the land; Nos. 2 will place the second saddle at about 12 feet distance, and in rear of the former and parallel to it, with the pins towards the river, and so on alternately. These men will assist in pinning the baulks to the rear saddle.

Nos. 3 BRING UP THE OARS, boat-hook and outriggers, and hand them to Nos. 2 of No. 1 raft; taking care to hand four oars and one outrigger to the starboard side, and the remainder of the stores to the port side of the bridge.

Prepare to boom out. No. 3 raft will man the front saddle, No. 4 raft the centre saddle, and No. 7 raft the rear saddle. Nos. 1 and 2 of each raft will man the ends of their respective saddles.

No. 3 the centre between the two outside baulks, the port on the port side, and the starboard on the starboard side of the bridge.

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* When boots can be obtained, they should be put on by the whole of the men of No. 2 raft, and Nos. 1 and 2 of No. 3 raft.

Prepare to lift. The whole of the crews of rafts Nos. 3, 4, and 7 will stoop down and lay hold of the saddle and baulks, and at the word '*Lift*' the whole of the superstructure will be raised up.

Boom out. The bridge is pushed gently out, until the pontoon to be inserted is in its proper position under the saddle.

Down. The superstructure is laid gently on the ground, and the requisite stores required for another bay brought up; and so on until the length of bridge is completed.

After the bridge is completed, the men on the bridge go ashore and fall in by rafts, in a line with and near the head of the bridge; the Non-Commissioned Officers of each raft having previously supplied themselves with eight rack sticks and lashings, two breast lines and two grummets, to make fast the steering oar.

Form by threes on your respective Rafts. The whole move off together, and when arrived on the bridge are not to be allowed to keep the step, as in military movements,—Nos. 1 and Nos. 3 halting on their respective rafts over the pontoons, and Nos. 2 in the centre of the rafts, the Non-Commissioned Officers in the centre of the bay on the lower side of the bridge.

The Non-Commissioned Officers should immediately make fast their breast lines on the stream side of their own raft to that of the raft nearest the shore. The rack sticks and lashings should be reeved through the handles of the pontoons, those for the starboard * side of the bridge to the starboard pontoon, and those for the port side of the bridge to the port pontoon.

Rack down. At this word each man will provide himself with a rack stick and lashing, and each Non-Commissioned Officer with two; Nos. 1 and Nos. 3 place the oars and outriggers in their proper positions, and Nos. 2 hand them the rack sticks and lashings; Nos. 1 and 3 will rack down over the pontoons, Nos. 2 over the centre of the rafts, and the Non-Commissioned Officers over the centre of the bays. The outriggers are placed over the centre of the pontoons, the middle row-lock being over the belaying cleat of the saddle.

The oars are placed, two blades being towards the head of the bridge and two towards the shore; the looms of the oars resting on each other, to bring them as close together as possible; the lap of the oars and outriggers will then be in the centre of the raft and bay, and they will be firmly secured by a rack stick and lashing.

This is a most important operation, and adds greatly to the strength of the bridge; it should be frequently practised by the men before the bridge is broken up. The Non-Commissioned Officers should at all times make themselves perfectly satisfied that the whole of the rack sticks and lashings are properly secured.

When the baulks are laid at close order for the passage of heavy artillery, the bridge is strengthened by passing one of the side pieces under the ends between the two first holes in the baulks, and they are lashed with the carriage lashings by reeving them through the holes of the baulks, and then making fast by frapping turns round the whole, drawing the lashings close up to the side pieces between the baulks.

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* In speaking of the starboard or port side of the bridge, it is supposed that the river is to the front when standing on the shore from which the bridge was formed.

TO DISMANTLE THE BRIDGE.

Prepare to dismantle. In dismantling the bridge, the same distribution of the men holds good, each man undoing what was previously done by him at the formation of the bridge.

Dismantle. The chesses connecting the bridge with the shore are to be first taken off, and the bridge is then to be drawn towards the land by the baulks, till the first pontoon comes to the bank of the river; its saddle is then unlashed, and the pontoon is withdrawn by the proper numbers detailed in the formation of the bridge, viz. Nos. 2 of No. 3 raft. In like manner two more sets of chesses, and two more pontoons, are to be withdrawn from the saddles, so that three saddles, with their baulks pinned to them, are on shore. The baulks of the first raft are then unpinned and removed, and the bridge being drawn further in, the same process is repeated until entirely dismantled.

BRIDGE, BOAT.*—Plate VIII.

Small craft should be collected from up and down the stream, as well as from tributaries to the river; and when a bridge of this sort is contemplated in the presence of an enemy, a rapid and well-disguised movement should be made to collect the boats.

Such vessels as are built for cargo are best adapted to this purpose,—neglecting the slighter kinds of boats used for passengers only, except the few that may be necessary during the construction of the bridge.

As soon as they are assorted to each side of the river, the inequalities of size, and the irregularities that would be thereby produced in the bridge-floor, must be made good by trestles (figs. 1, 2, Plate VIII.) along the centres of the boats: the baulks must lie on these trestles, and never on the gunwales of the boats, which would certainly be crippled.

Allowance must be made for the degree of pitching and rolling to which the boats may be subject,—in the distances between them,—and in the manner and extent to which the baulks are to overlap one another at the ends. On the Adour Bridge, this motion was occasionally so great as to render it then fit only for Infantry. Whether the boats are to be anchored stem and stern throughout, or partially so, will depend on liability to turn of tide, backwater, floods, &c.

Bridges should, in general, be on straight lines across the river; the idea of their receiving strength from an arched form is fallacious, as no general lateral abutment takes place; each part being mainly dependent on its own moorings: in tide-rivers, likewise, this arrangement would be reversed every tide.

The sizes of the boats cannot well be specified; the most suitable must be taken that can be had; but, generally, they should be such that when the bridge is completed, and under its extreme burthen, the boats' gunwales should be at least 1 foot above the water.

Mem^{m}.—The Bridge over the Indus, by Capt. G. Thomson, H.E.I.C. Engineers, is recommended as an *excellent* study in Boat Bridges.—See Professional Papers, vol. iv. p. 92.

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* Abridged and modified from Sir H. Douglas.

BRIDGE, ROPE.—Plate IX.

Rope Bridges of a complicated description are not given, being unfit for military purposes, and especially objectionable on the grounds of economy, and liability to destruction.*

Those that are suited to temporary and military purposes are extremely simple: that made by Colonel Sturgeon, over the broken arch at Alcantara, in 1810, is given, chiefly from a drawing by the Staff Corps. This Rope Bridge spanned 100 feet; it was removed and replaced with ease, and was readily packed for transport. It was adopted from the impossibility of procuring proper timber to restore the communication.

Colonel Sturgeon's Bridge is constructed thus:—Three hawsers, A, are strained between 2 beams, B; over this, by means of the blocks and tackles, C, is drawn the net-work, D (stretched between the 2 beams, E), which supports the cross-beams, F, bearing the joists, G, and the planking, H. The whole is steadied by the guys, I.† The net-work outside the planking is covered by a stripe of tarpaulin, J, to prevent horses, &c., from being frightened; and a light side fence of rope, K, supplies the place of a hand-rail.

A and B are hauled tight by capstans to the 5 tackles, C, at each end. B and C lie in grooves cut in the road-way: B also passes through the parapet wall on both sides, if for the restoration of a bridge; or is abutted behind piles, or trees growing on the banks, if for an independent bridge. D and E are strained in like manner. D consists of one rope, passed 19 turns round E, within the breadth of 18 feet; the 10-feet lengths for F are marked off, and well tarred at the places where F are to lie: these 10-feet lengths are subdivided into 3 parts to mark the meshes, which are gathered in, and seized with spun-yarn. F are notched at 1-foot intervals, so as to fit down on the net-work, to which they are lashed by a running lashing of Hambro' line. G in 10 rows; these are rounded off, and strapped with iron at the ends; the holes *a, a, a,* fig. 3, admit of adjustment in the wood-work, when any change of length takes place in the rope-work, from contraction by wet, or extension from the weight supported. The planking, H, is looped together by spun-yarn at *b, b,* fig. 1.

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* As an extreme case, however, a sketch of a Field Suspension Bridge, somewhat on Dredge's principle, is given, fig. 9, Plate XIV. The strong cables that are necessary where all the weight rests on two or three main ropes are not always to be had: in the present instance, where the burthen is divided among many suspenders, far smaller and more generally obtainable materials will suffice. In the sketch, the point A is obtained by a sufficient number of jumpers sent into the face of the rock; the ends of the ropes being secured in like manner above, if no trees, &c., &c., are to be had. Should no such local resources for fixing A and B present themselves, strong trestles must be substituted. This sort of bridge must be well steadied by guys.

† Cannot be shewn in the Plate: they led from the centre of the bridge, on both sides, to the banks above and below.

Table of Materials and Transport necessary for a Bridge as above described.

Reference to Plate.	Stores.	No.	Dimensions. Length.		Breadth.		Depth.		Weight. Detail.	Gross.	Loads of a 4-wheeled Waggon.
	TIMBER.		ft.	in.	ft.	in.	ft.	in.	lbs.	cwt.	
									At 40 lbs. per cubic foot.		
B	End-ties	6*	15	0	1	0	1	0	3600		2
E	Main beams . . .	2	22	0	1	0	1	0	1760		1
F	Cross ditto	11	20	0	0	6	0	8	2960		2
G	Joists, single . . .	50	11	4	0	2	0	6	1920		1
G	Ditto, double . . .	100	11	4	0	$1\frac{1}{2}$	0	6	2840		2
H	Planking, 9 inches wide	187	12	0	0	9	0	$1\frac{1}{2}$	8440		6
			Total timber . . .						21520	193	
	ROPE-WORK, &c.								Calculated on weights as given in 'Cable.'		
A	Hawsers	3	170	0	9-inch.				1581		1
C	Tackles	10	96	0	$4\frac{1}{2}$-inch.				749		1
C	Lashings to blocks, &c.	40	30	0	$4\frac{1}{2}$-inch.				936		
D	Net-work	1	2000	0	3-inch.				700		
I	Guys	4	200	0	3-inch.				280		
K	Side fences	2	400	0	$1\frac{1}{2}$-inch.				72		1
	Lashings to F . . .	11	50	0	Hambro' line.				50		
J	Tarpaulins	2	100	0	3	0	"		448		
	Spun-yarn	4	cwt.		"		"		448		
	Treble blocks . . .	20	1	3	"		"		800		1
	Double ditto . . .	8	0	9	"		"		62		
			Total rope, &c. .						6126	55	
			Total weight of bridge .						27646	248	18

BRIDGE, BOAT AND ROPE.—Plate VIII.

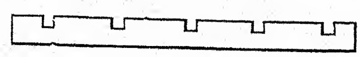
The Bridge over the Adour, designed by Colonel Sturgeon, of the Staff Corps, and executed by the Royal Engineers, is the finest example on record of this kind of communication.

The arrangement of the tension gear is much the same as that used at Alcantara.

The Plate and Description are from Sir H. Douglas, and Sir J. T. Jones, R.E.

"Forty-eight chasse-marées were taken up in the ports of St. Jean de Luz, Socoa, and Passages; collected at Socoa, and each loaded with

48 3-inch planks, 9″ × 12″.

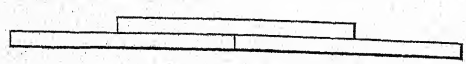
1 Sleeper, 10″ × 10″, notched thus: 

2 Hand saws.

2 Axes.

2 Skeins Hambro' line, to lash the planks to the outside cables. Two men of the

* In mountainous countries, it will rarely be practicable to carry beams long enough to go through both parapet walls of such a bridge; nor is it always easy to obtain them. Three pieces have therefore been allowed for each end-tie, to be made into one beam thus,—by lashing them together: provision is made in C, above, for these lashings.



Corps of Royal Sappers and Miners were put on board each vessel to level the waist-boards with the decks, so that the cables might be stretched across as soon as the vessels should be moored. The floor was supported by five cables, lashed in the notches of a sleeper placed fore and aft, on the deck of each vessel. Five cables, 13 inches in circumference each, and 120 fathoms long, were put on board the chasse-marées destined for the centre of the bridge, and so coiled that they could be handed up the hatchways, right and left, at the same time.

"The river was bounded on both sides by perpendicular stone walls, 14 feet high, and the same thickness. That on the left bank was backed behind by sand, level to its surface; while the ground behind the wall on the right bank was 12 feet lower than the top of the masonry, and covered at high tide by 7 feet water. The rise of the tide, at springs, was 14 feet.

"On the right bank, the end of each cable was fastened to an iron 18-pounder, which was thrown over the wall. Those parts of the cables which rested on the masonry were served with green bullock hides, to prevent rubbing. On the left bank, they were stretched by capstans and gyn-tackles, fixed to a frame of timber laid on the sand behind the wall, 3 feet lower than the top of the masonry, (Bridge, Plate VIII. figs. 5, 6,) and loaded, in the rear, with sand-bags, to prevent it from tilting upwards.

"The chief disadvantage in substituting cables for beams is, that the navigation of the river cannot be opened by removing one or two boats, with their proportion of floor; for the cables being stretched by capstans from bank to bank, and only borne by the boats, cannot be secured but by spanning the whole river. Cables are, moreover, expensive, and with every precaution very soon chafe. Hence the application, excellent as a temporary expedient, should be replaced by beams as soon as they can be procured; when care must be taken to apply them so as to allow for the undulating motion of the bridge in gales of wind."

Memorandum.*—In the first instance, the boats had each one anchor ahead, and another astern, so as to meet the turn of tide; but, from the violence of the current, it was soon found that not less than two anchors at each end were necessary. In this case, great care is required to avoid fouling the anchors, and it will be best done by their being cast, as it were, 2 deep, by the alternate boats throwing them out as far from, and the others as near to, the bridge, as can be done with safety and convenience.

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* By a R. E. Officer who saw the bridge.

BRIDGE, CASK.—Plate XI.

When no Pontoons or Boats can be had, Casks, formed into Piers, offer a good substitute; they were thus used by Lieut.-Colonel Goldfinch, R.E., over the Nive, in January 1814.

The Chatham practice is given, as arranged by Lieut.-General Sir Charles Pasley, based on the above and other experience; leaving modifications to the circumstances of the service under which they are required.

General Pasley's Bridge consists of rafts managed much on the same principle as the modern Pontoon Equipments; each raft composed of the ordinary superstructure laid on two piers of seven casks each,—put together as shewn in figs. 1, 2, 3, Plate XI.

The stores for such a raft will be—

14 Casks, or water-butts, 4′ 3″ long × $\begin{Bmatrix} 2' \, 9'' \\ 2' \, 2'' \end{Bmatrix}$ averaging 174 lbs. in weight.

A 4 Side pieces, each 21′ × 4″ × 5″.
B 4 Slings, each 36′ of 2½″ rope.
C 24 Braces, each 18′ of 1½″ rope.
D 2 Transoms, 10 Baulks, (5 for Raft, 5 for Bridge,) 2 Spare baulks, } each* 22′ 8″ × 4″ × 4½″.
2 Anchors, cables, buoys, and lines.
2 Boat-hooks; besides oars, rack lashings, &c.
Plank, or fascines, for the floor.

When a bridge is to remain in the water for any length of time, chain may be substituted for rope in the parts immersed; or, as was done on the Nive, the casks may be enclosed in an open frame of wood-work.

At open order, each raft will give about 37 feet of bridge, about 18 feet wide, and will bear Infantry, Cavalry, and a light 6-pounder.

At common order, each raft will give about 31 feet of bridge, and will support a medium 12-pounder limbered up, complete with ammunition.

When heavy artillery is to be passed, it must be towed on rafts consisting of three or four piers instead of two; the floor proportionally strong; thus the weightiest ordnance may be taken across, the platform being about 30 feet long × 18 feet wide.

To insure stability, the piers should never be less than 20 feet long in any case.

Cask rafts can be rowed with tolerable facility in still water, or in moderate currents, but not against a strong one or a high wind. In rapid rivers they are apt to have the stream end borne down; which must be remedied by giving a stream anchor and cable to each pier, secured, not immediately to the pier itself, but to a cask close in front, which is interposed as a breakwater, and which is attached to the end of the pier: or the force of the water may be reduced by a projecting triangular breakwater of 1½-inch plank, instead of the detached cask.

It is desirable to have the anchors and cables laid as moorings before the rafts are brought off to their stations, which are marked by the two continuous buoys supporting the ends of the cables. If only a small boat, or Blanshard's Infantry Raft, can be had, it should be used in taking out the anchors; if not, a cask raft must be used, taking care to work and drop *down* the stream as much as possible.

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* If these cannot be obtained in one length, they must be made by lashing two shorter pieces together.

The following Table is arranged in reference to Commissariat and Admiralty Casks, being those that may often be available; or will serve, by approximation, for others.

Cask, &c.	Content.	Weight when empty.	External Dimensions. Head Diam.		Bilge Diam.		Length.		Extreme Buoyancy in Fresh Water.	Time* of putting together. Men.	Hours.	Remarks.
	Imp. gals.	lbs.	ft.	in.	ft.	in.	ft.	in.	lbs.			
Leaguer . .	164	230	2	6	3	$1\frac{3}{4}$	4	$10\frac{1}{2}$	1746	2	4	Used for water before the introduction of iron tanks.
Butt . . .	110	168	2	2	2	9	4	$4\frac{1}{4}$	1173	2	3	
Puncheon .	72	135	2	1	2	4	3	5	694	2	3	Chiefly used for rum.
Hogshead .	54	109	1	11	2	4	3	0	576	1	3	
Barrel. . .	34	71	1	9	2	1	2	7	407	1	2	
Half-hogshead	26	59	1	7	1	$10\frac{1}{2}$	2	4	292	1	2	
Kilderkin .	18	45	1	5	1	8	2	0	194	1	2	
Tierce. . .	37	58	1	9	2	1	2	$7\frac{1}{2}$	428	1	3	Beef and pork.
Irish barrel .	25	47	1	6	1	$8\frac{1}{2}$	2	4	275	1	2	

Hutton's Rule for contents of casks, modified for imperial gallons, becomes—

$$(39\,D^2 + 25\,d^2 + 26\,D\,d) \times L \begin{cases} \times \cdot 0003143 & = \text{content in lbs. water,} \\ \times \cdot 00003143 & = \text{content in gallons,} \\ \times \cdot 000005043 & = \text{content in cubic feet,} \end{cases}$$

where D and d = bilge, and head diameters; L = length; all in inches.

BRIDGE, TRESTLE.—Plate XI.

These are chiefly applicable to rivers in hilly countries, where the stream—liable to sudden swellings—is generally too deep to be forded; and when a Pontoon, Boat, or Cask Bridge is not applicable, cannot be obtained, or cannot be forwarded.

The trestles can be made of rough materials on the spot; or may be framed in the rear, passed on in pieces on mules, and quickly put together on the bank.

To give stability when sudden risings may be expected, or when the current is strong, heavy stones may be piled up inside; strong sheer lines, or even cables, may be passed across, to which the heads are to be lashed as the trestles are laid, successively; large killicks may also be thrown out.—See fig. 6, Plate XI.

The figure given is nearly that of a Bridge by Lieutenant Wright, R.E., attached to Sir Rowland Hill's Division in 1812. If of yellow pine, such a trestle will weigh about $9\frac{1}{2}$ cwt.; and the superstructure per bay of 15 feet, including cables, will be about 16 cwt. in addition. In the above instance, fascines were used where planking could not be obtained.†

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* The workmen are supposed to be good, and the materials only to require putting together.

† The Belgians use a tripod trestle.—*Editors.*

According to Sir Howard Douglas, Colonel Sturgeon, of the Staff Corps, threw a bridge over the Agueda, at the ford of Marialva, near Ciudad Rodrigo, 396 feet long, on 18 trestles, which were well loaded with stones, secured by coarse wattling, which allowed the water to pass through.

In the construction, care should be taken not to weaken the timber by mortises and tenons, or by halving. If the pieces are to be carried, and used a second time, it would be desirable, if iron and a small forge can be obtained, to make a certain number of bolts and screws for fixing the work together.

BRIDGE, RAFT.—Plate XII.

The last expedient that should be adopted by an army in motion;—to such, it is an indifferent substitute for Boats, Pontoons, or Casks, either when employed as a Flying Bridge (Trail, or Pivot), or as a Fixed Bridge.

It has the lowest degree of buoyancy* and general manageability, and is inapplicable when the passage of a river is likely to be contested with animation.

Its merits are, that, at the expense of time, it can be constructed with less experienced workmen; that it saves carriage, as it can be only made of materials on or near the spot,—cables, and a few such stores, being all that is indispensable from the rear; that it is not liable to be sunk; and, if allowed to remain undisturbed, will last a long time with moderate repair.

Plate XII. gives the general form and construction. The rafts should not be less than 45 feet long; they are best bound together by withes or ropes, and stiffened with cross and diagonal braces. They are most readily built on the water; but, if they must be made ashore, they should be put together across two parallel baulks, or trimmed trunks of trees, sloping towards and close to the river, so as to be easily launched. With numerous and experienced workmen, such a raft *may* be made in 5 or 6 hours. An independent raft will require (on an average) two rows of trees at least to float as many men as can stand upon it, unless the trees are very large,—when they cease to be manageable, and are scarcely applicable.

Whether they are to be anchored in connection with a sheer line or not, depends on circumstances; the anchor, in such cases, may well be the fisherman's wooden killick† (see Plate XI. fig. 6), unless the bridge is to last for any time, or is liable to unusually violent currents. Such were, however, used in the Passage of the Indus in 1839; and by a sufficient increase to their number and weight (even to ½ ton) ,very powerful streams over rocky bottoms may be mastered.—See Professional Papers, vol. iv. Paper VI.

The figure is nearly the same as that given in Laisné's 'Aide-Mémoire.'

BRIDGE, PILE AND SPAR.—Plates X. XI.

Piles are used merely to obtain supports, either as piers or abutments; they are especially applicable when deep and wide rivers are to be crossed; but the nature of the bed must be considered before any operation can be attempted.

Pile-engines form part of the French Engineer Field Equipment; the rough approximate expedients for supplying their place, either as a ram or as a tilt-hammer, are too obvious to require a description.

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* And if down for any length of time, becomes water-logged.

† Clay secured by matting may be used.—*Editors.*

Spars, baulks, &c., can be applied as superstructure, to either a piled or any other pier or abutment; whether to form, or to restore, a communication. The series of such bridges as may be used in field operations gives much of the earlier history of framing and trussing, in reference to roofs as well as bridges. Of these,—the 1st would be merely spanning the opening, with timber sufficiently long, and covered with cross planks; or, in default of these, with fascines.

The 2nd, and next rudest form of arch (particularly observable in Egyptian architecture), is very strong, easy of construction, and of frequent occurrence in Nova Scotia (see Plate X. figs. 1, 2); the timbers being notched roughly into one another, as is done in building log-houses. A few of the upper courses may be trenailed down.

The 3rd step is given in figs. 3, 4.

The 4th in figs. 5, 6. In the construction of this, the first thing is to form a horse, or trestle, on which the remainder of the work is to lie until secured: to effect this, cut a step, *a*, low down, and well in rear of, the arch, so as to admit of a strong party standing there to pull over, and hold up with ropes and by main force, the 2 pair of spars, *b*, *b*, *b′* *b′* and the cross piece, *c*, previously lashed together, and fitted with 4 guys at each end;—thus firmly held up, 2 light and active men climb up, and lash *e*, *e*, *d*, *d*: a general framing being thus made, the rest may be added in the following order:—the remaining rafters, *g*,—the cross pieces, *c′*, *j*, *j*,—the remaining collars, *d*, —the cross pieces, *f*, *f*,—the frames, *h* (like ladders on their sides), going entirely across as intermediate supports; and finally, the joists and planking, or fascines. Diagonal braces, *i*, *i*, *i*, must be used, to give general lateral stability during the process and at its completion.

The 5th, figs. 7, 8, applicable when 2 spars will not reach across: it may be executed in much the same way; paying great attention to fix diagonal braces as soon as possible, even if but temporarily.

Both of these can be more readily thrown across an open stream (where there is plenty of room to extend the guys, and put on main force in the first instance,) than, as above, in the repair of a bridge.

Figs. 9, 10, Plate X.; figs. 11, 12, 13, Plate XI., are common in Canada.* In a roof, the weight is thrown on the rafters, and the cohesive strain on the tie-beam and king-post. In these Bridges, the tie-beam bears the transverse strain, whilst the tendency is no longer to snap, but to crush, the rafters, as well as to pull up the king-post, or force its head off. In fig. 11, the rafters, *a*, *a*, of fig. 9, Plate X., are represented by the shores, *b*, *b*.

The above, as elements, can be occasionally combined,—*e. g.*—fig. 3 with figs. 9 and 12; or they may be repeated as separate and successive arches, as well as extended in width, so as to be doubled or trebled laterally, as in fig. 13, &c., &c.

The minor details of construction, in the above, are left to the general experience of the Officer; but he cannot, in figs. 9 to 13, too carefully avoid crippling the main pieces, by halving, or by using mortises and tenons, dovetails, &c.; all of these, not only enfeebling the whole, but (the mortise and tenon) rendering it difficult to take down a bridge satisfactorily for repair or removal; and the dovetails giving a treacherous hold, especially in the green woods likely to be used in field practice. In lieu of these, couplings should, as much as possible, be made by mere fishings, covering and steadying the abutments,—by the simplest kinds of keyed scarphing,—or by iron strapping, if obtainable.

Troops should not be allowed to keep step in marching over Field Bridges, as they are rarely stable enough to bear the accumulating oscillations thereby produced.

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* See Professional Papers, vol. iii. p. 163.

A small iron Suspension Bridge was some few years since carried away by the neglect of the Officer in command of a detachment to give the word 'March at ease.' They who have been stationed at St. John's, Montreal, will remember how advisable this precaution was in crossing the Richelieu by the long feeble wooden bridge built on the resources of a private speculator.

BRIDGE, FLYING, SWING.—Plate XIII. figs. 1 to 5.

Such Bridges, as well as those of Boats, are frequently used on the Rhine—a river on which permanent structures would be objectionable in certain military points of view, as well as in those of a mercantile nature, as impeding the great timber rafts which are constantly floated down from the upper Rhine as long as the river remains free from ice.

In this description of Swing Bridge, the necessary obliquity to the stream is given by the rudder. Fig. 1 shews the bridge in plan as it swings from side to side at the lower end of a mooring chain, about 650 yards long,* the upper end being well fixed and anchored in the centre of the stream, and the intermediate length supported on boats.

The wharfs which receive the bridge on its arrival are moveable, and so arranged by floating them on boats like those of the bridge, that they can be adjusted to any state of the waters: there is a difference of 30 feet between the extreme levels at Bonn on the Rhine.

References. Fig. 1.

a, the platform, say 3″ pine planking on rafters 8″ × 8″ and 4 feet apart, lying across the boats; ends projecting 4 feet beyond the outer sides. The boats are very strong, decked, and nearly flat-bottomed; they bear the platform as it rests upon the deck, about 5 feet above the water.

b,† the horse on which the mooring rides and traverses; the traversing beam is under, and parallel to, the top beam.—See fig. 2.

c, from the adjusting windlass, *c* to *o*, the mooring is a 9″ hawser; but from *o* to the pivot, a chain composed of bar links 2 feet long, and connecting rings; both links and rings of about ¾″ square bar iron.—See fig. 3.

The length of the mooring depends on the width and velocity of the stream; but it is not customary to make it less than the breadth of the river. At Bonn, between the bridge and pivot, it rests on 9 boats.—See fig. 4.

d, *d*, rudders.

e, *e*, battens nailed to the deck, to which the steersman stays that tiller at which he does *not* stand, by means of a sort of boat-hook.

f, *f*, cross-beams, a few inches above the deck, which with the heads *g*,

g, *g*, serve for belaying, &c.

h, *h*, small capstans to check the bridge when it arrives at the wharf, as well as to bring it up square alongside of this last: a 6″ rope is used for this. The checking is

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* According to the Belgian Engineer Regulations relative to Field Bridges, the length of the chain should be not less than 1½ width of river.

† In the Swing Flying Bridge over the Oder, (between Freienwalde and Stargard,) instead of a 'horse' there is a mast; and in lieu of one chain mooring in the stream there are two 3-inch ropes fastened near the top of the mast, which are wound up on each bank by horse-power, (to assist the stream and rudders,) on weams, alternately, as the ferry moves from side to side. The Oder is here about 100 yards broad, and is crossed in about 6 minutes.

also assisted by letting fall a drag-board, which hangs ready across the bows, at *q*, *q*, as soon as the bridge comes within a few yards of the side.

i, *i*, little wooden rollers, set vertically in the framing of the railing.

j, connecting beam.

k, *k*, hatches.

l, seats for passengers.

m, *m*, railing.

n, *n*, entrances.

o, point of junction of cable and chain in the mooring.

p, *p*, anchors in case of accident: a row-boat is likewise attached to the bridge.

In the winter, should there be much drift ice, these bridges become useless; their place is then supplied by common ferry-boats.

The preceding account is that of one of the largest bridges: fig. 5 refers to one of the smaller class, at Linz, also on the Rhine.

It consists of only a single boat about 12 feet wide, and perhaps 30 feet long.

The oblique direction in this sort of Swing Bridge is given by the chain *d*, *b*, *e*. *a*, *b*, *c*, is the mooring.—*d*, *b*, *e*, a small chain passing through a block at *b*, and wound up at *d* or *e*, according to the side to which the boat is moving. To assist the conversion of the direct force of the stream into the necessary oblique one, 4 small 'lee-boards' are slung at the sides at *f*, *f*, *f*, *f*.—*c*, *g*, is a 'horse' as in the preceding, but the mooring is fixed only to the post *c*.—*h*, *h*, gang-boards let up and down like a drawbridge, from the 'horse.'

N. B.—*b* is in the last boat supporting the mooring.

BRIDGE, FLYING, TRAIL.—Plate XIII. figs. 6 to 9.

The figure is taken from the Règlemens Provisoires of the Belgian Engineers. Such a flat-bottomed boat as fig. 5, which is easily constructed, would also be applicable: in default of boats, a light raft* must be substituted.

In the old Flying Bridge at Plymouth there was no intermediate sling, *d*, *b*, *e* (fig. 5); but the boat slid along a 6-inch sheer-line, received on board, and led along 2 rollers (figs. 8, 9), close under the gunwale on one side. The boat was moved across by 2 men constantly walking forward, and warping on the rope by a short wooden bat, with a deep notch in it, sufficiently large to take a hold; each man returning aft as soon as he reached the head.

The following somewhat novel, and apparently effective, resource in crossing rivers, may very appropriately close this series,—as the Flying Bridges just described are virtually ferries.

" The mode in which we passed the Oxus was singular, and, I believe, peculiar to this part of the country. We were drawn by a pair of horses, who were yoked to the boat on each bow, by a rope fixed to the hair of the mane. The bridle is then put on, as if the horse were to be mounted; the boat is pushed into the stream, and, without any other assistance than the horses, is ferried directly across the most rapid channel. A man on board holds the reins of each horse, and allows them to play loosely in the mouth, urging him to swim; and thus guided, he advances without difficulty. There is not an oar to aid in impelling the boat; and the only assistance from those on board consists in manœuvring a rude rounded pole at the stern, to prevent the vessel from wheeling in the current, and to give both horses clear water

* Blanshard's Pontoons are perfectly applicable in this case, figs. 6, 7, Plate XIII.

to swim. They sometimes use four horses; and in that case two are fixed to the stern. These horses require no preparatory training, since they indiscriminately yoke all that cross the river. One of the boats was dragged over by the aid of two of our jaded ponies; and the vessel which attempted to follow us without them was carried so far down the stream as to detain us a whole day on the banks, till it could be brought up to our caravan. By this ingenious mode we crossed a river nearly half a mile wide, and running at the rate of three miles and a half an hour, in 15 minutes of actual 'sailing;' but there was some detention from having to thread our way among the sand-banks that separated the branches. I see nothing to prevent the general adoption of this expeditious mode of passing a river, and it would be an invaluable improvement below the Ghats of India. I had never before seen the horse converted to such a use; and in my travels through India I had always considered that noble animal as a great incumbrance in crossing a river."—Burnes' 'Travels,' vol. ii. page 216.

BRIDGE.—Reconstruction of.

Communications may be re-established by all the preceding modes of passing rivers; those which seem most applicable to the repairs of broken arches are the simpler kinds of Spar Bridges, Plate X., and Rope Bridges, Plate IX. At Dresden, Laisné states that well-secured flat boats, bearing high trestles, were used as temporary piers. Where stability can be insured, a simple 'horse'* may be substituted for the trestle.

With reference to construction, as well as repair, of bridges, experience has shewn that in demanding labour and material, contingencies are not too high at cent. per cent.

BRIDGE, Field.—Demolition of.

An enemy's bridge can be destroyed by sending trunks of large trees,—or considerable quantities of small ones, to accumulate faster than he is likely to be able to remove them, so as to throw a strain on his cables;—or by heavy floats loaded with stones, having a short and strongly-fixed mast to prevent it from passing under the bridge.

These may or may not be combined with fougasses, in the shape of powder-boxes, arranged with a gunlock or a pistol inside, fixed to a projecting pole or poles, so as to explode on striking the boats, &c.

If any of the above be furnished with shells or grenades, to deter men from approaching, care must be taken to cut the portfires so as to explode at uncertain intervals.

These attempts should of course be made, if possible, at night, from the nearest accessible point, and on having ascertained the set of the current as nearly as may be. —*Chiefly from Laisné.*

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* For a figure of this sort of 'horse,' see Plate XIII. fig. 2; it is a two-legged trestle.

BRIDGE, Masonry.*—Demolition of. Plate XIV.—*See also* 'Demolition.'

In the destruction of bridges during the Duke of Wellington's campaigns, various methods were adopted, according to the circumstances of the case.

The bridges in the Peninsula were usually of stone, the arches from 20 to 40 feet span semicircular, and of one stone of 18 inches or 2 feet in thickness. The loading of the arches was sometimes of solid masonry, but commonly of loose stones or rubbish.

The object required generally was to destroy one arch; and in order to give the enemy the greatest inconvenience and delay, the largest arch, and where there was deep water, was preferred, excepting when want of time or ammunition made it advisable to select a particular one that might appear weaker than the others.

The simplest principle of mining a bridge was found to be by lodging the powder on the haunch of the arch, and as near as could be on the centre of the width of the bridge, with the line of least resistance through the arch.

The best mode of forming the mine was where the side walls of the bridge above the piers were slightly built and easily got at, and the loading of the arch of loose rubbish: a small gallery was then run in A, Plate XIV. fig. 1, about 5 feet from the arch-stone; and when at the centre of the width of the bridge, a return was made to the arch, and the powder lodged against it. There are not many occasions where this can be done under a very considerable time; but when practicable it has many advantages: the greatest resistance is obtained to the sides and above; the ammunition is less likely to get injured from wet penetrating to it; there is no obstruction to the road over the bridge while preparing, and less danger of accidents after it is loaded.

In this case, the powder, saucisson, &c., are applied in the usual manner in mining; and the end to be lighted is kept within the surface of the wall, to be sheltered from the weather.

The common and quickest mode of mining a bridge is by sinking down from the road above to the arch, and lodging the powder in one mass on the centre of its width. To do this with good effect, the shaft, C, B, fig. 2, should be sunk where there will be the greatest resistance gained above and to the sides, as at B. As the arch gives so much more resistance than the materials with which it is loaded, the distance to the surface, therefore, should be two, or three, or even four times more, at least, in those directions, than in that through the arch, in proportion to the nature of those materials.

In this way arches have been blown down with 45 pounds of powder, and after five or six hours of labour.

The shaft should be sunk on one side of the centre of the width of the bridge, as at C, fig. 3, and a little return made at the bottom to gain that situation for the powder, by which means there will be more solid resistance above, and a greater width of road left open during the operation.

In loading, the saucisson was brought up the shaft to within about 1 foot of the surface of the road, and then carried along a gutter or drain to the side of the bridge where it was lighted, whereby the road was entirely cleared, and a premature explosion from accident less likely to occur. The upper surface of the road was drained off as much as possible, to keep the wet from penetrating to the powder.

When there is no time to sink a shaft as deep as might be wished, as great

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* The whole of this Paper on Demolition by Lieut.-General Sir J. F. Burgoyne, G.C.B., R.E.

resistance must be obtained as can be, by sinking as deep to the arch as there is time for, and increasing the effect by a loading of as much stone or other heavy materials from the parapet walls or elsewhere as can be applied.

A bridge across the Carrion, at Dueñas, was required to be mined in great haste, and it was found that the loading between the arches was of solid masonry: an opening was therefore made down to the crown of the arch, D, figs. 4 and 5, about 2 feet 6 inches only; 250 lbs. of powder were lodged in rather a longitudinal direction along the width of the bridge, and a loading, C, C, fig. 4, applied of heavy stones and rubbish, as high above the road of the bridge as could be, without preventing carriages from passing: when fired, it made a gap, E, E, E, E, across the bridge, of 15 feet, which was about half its span.

The French declare that 100 pounds of powder, laid on the crown of an arch, and without loading, would destroy it; but, in a well-built bridge, I should be sorry to apply so small a quantity.

As on service the time at command for this kind of operation is very uncertain, it is a common and good mode to commence preparing in two places, one on the crown of the arch, and the other on the haunch; and then, if not allowed time sufficient to complete the latter and better mode, the powder can be applied on the crown of the arch, and exploded with or without a loading of rubbish, according to circumstances; and it is much better to do that than to lodge the powder in a shaft only partly sunk down to the haunch, although it should be deeper.

In some cases where the bridge is very wide, and the operation can be carried on with nicety, it may be right to divide the powder into two mines, F, and G, fig. 6, across its width; but in a rough operation, I would certainly never divide the powder; for although it was said once that a hole was blown through the centre of a wide arch, and a passage left on each side (which, however, I do not believe), if it was so, certainly that same quantity of powder that gave so nice a shock would not have injured the arch at all if divided.

I have seen an instance where about half of the width of a bridge, F, G, H, fig. 7, was blown down, which probably arose from dividing the powder in this manner.

There can be no reason whatever for dividing the powder between the different sides of the arch, as at I, K, fig. 8; by doing so, a failure took place on the Corunna retreat; and if it succeeds, there can be little doubt but that one of the mines would have done as well. Wherever the powder is divided, the explosion of the whole should be simultaneous; the arrangements require much precision, and the chances of failure are of course multiplied.

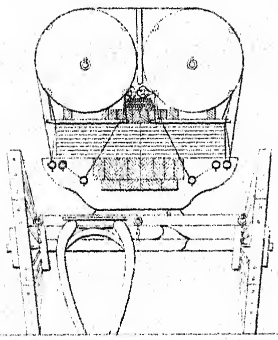
Where a bridge is narrow, there can be no occasion for sinking the shaft down to the arch much deeper than half the width of the bridge, as the want of resistance at the sides will render the additional vertical resistance superfluous. On one occasion, a failure occurred from a shaft being sunk down to a pier with the intention of destroying two arches; but which, although great perpendicular resistance was gained, blew out at the sides, and left the two arches perfect.

When the effect of a mine can be secured to cut through the arch, the greater resistance that can be given, even in that direction, the better, as it will increase the effect over the whole width of the bridge.

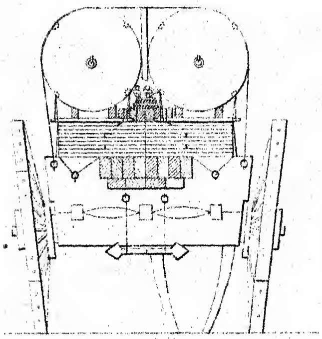
As it generally happens on service that the mine cannot be laid according to nice calculation, after applying it in the best way which circumstances will allow, the effect must be gained by increasing the quantity of powder. Under the chance of different difficulties that might occur, it was customary, when practicable, to send two, three, and even four barrels of powder, of 90 pounds each, for the destruction of a bridge, although one would usually be sufficient.

BLANSHARD'S LARGE BRIDGE.

Front Elevation.
Fig. 1.



Rear Elevation.
Fig. 2.



Side Elevation.
Fig. 3.

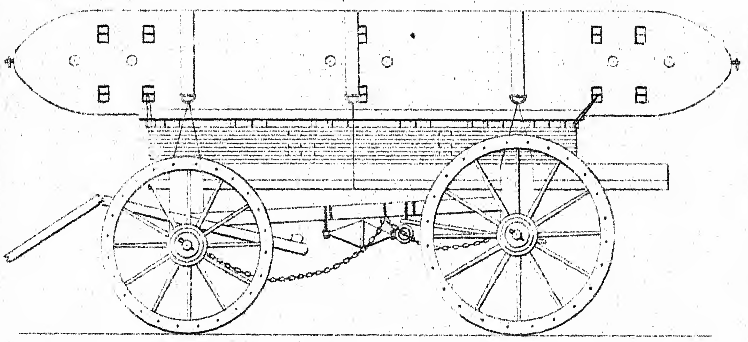
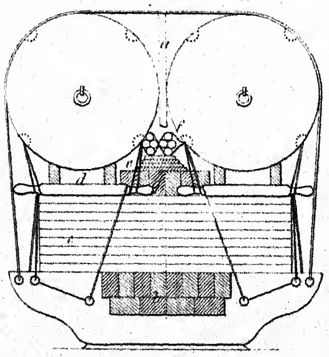


Fig. 4.



a. Bag filled with Sawdust &c.
b. Baulks and Side pieces.
c. Chesses.

d. Saddles.
e. Cable.
f. Oars and Boat hook.
g. Outriggers.

J. W. Lowry fc.

John Weale, 59, High Holborn, 1844.

BLANSHARD'S LARGE BRIDGE.

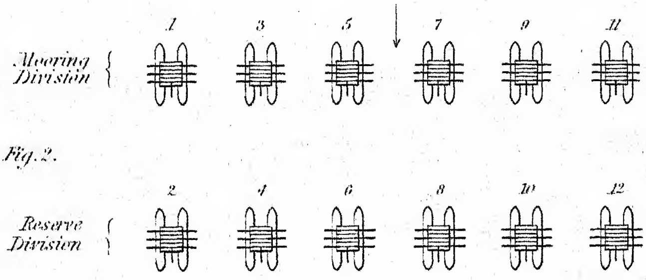


Fig. 2.

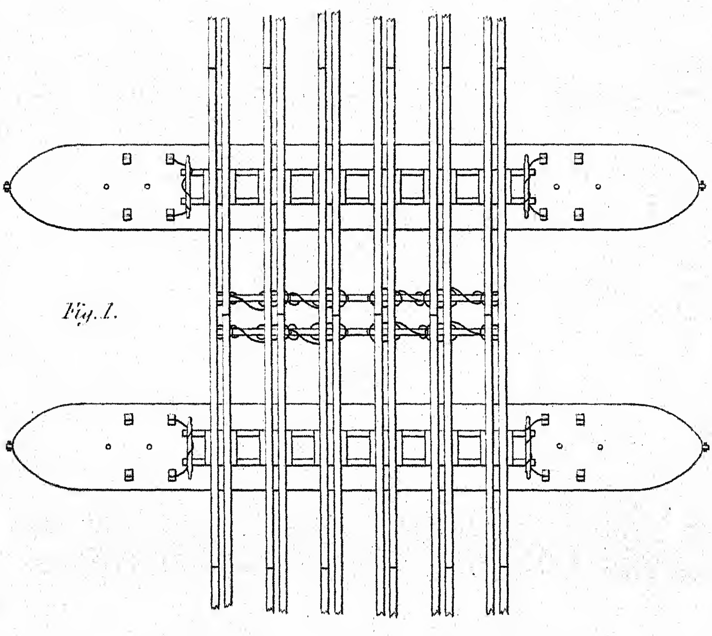


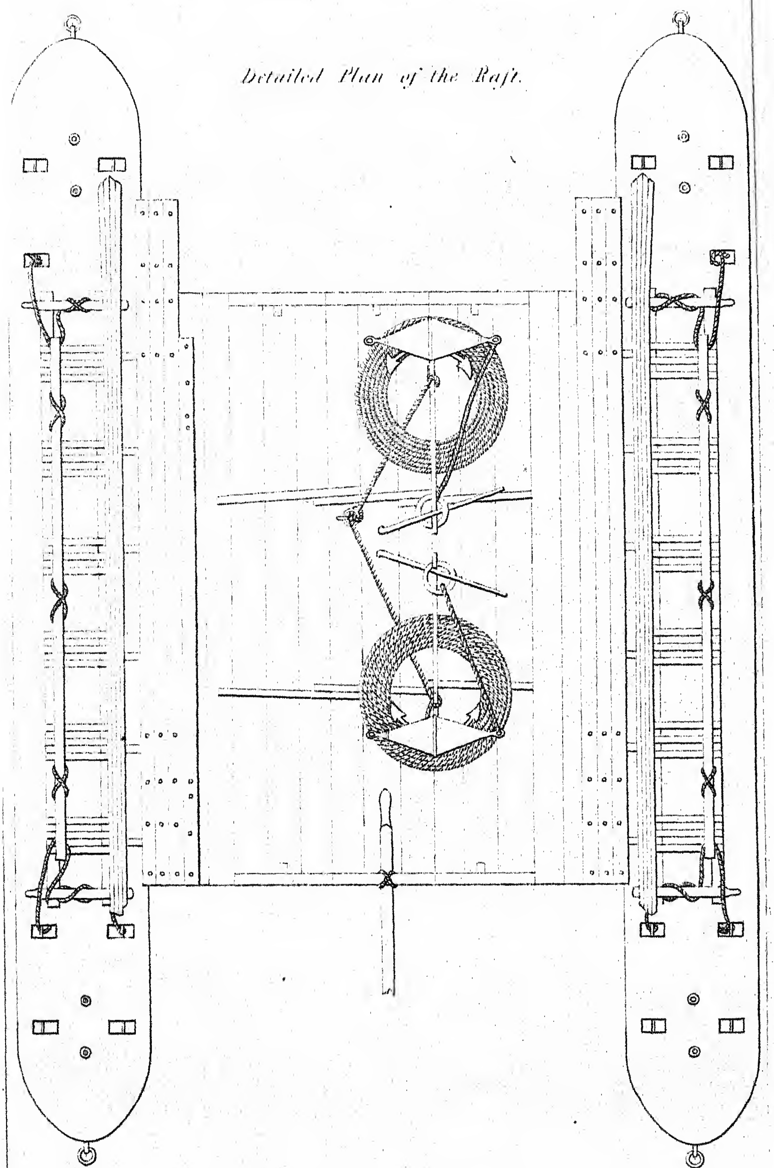
Fig. 1.

J.W. Lowry fc.

John Weale, 59, High Holborn 1841.

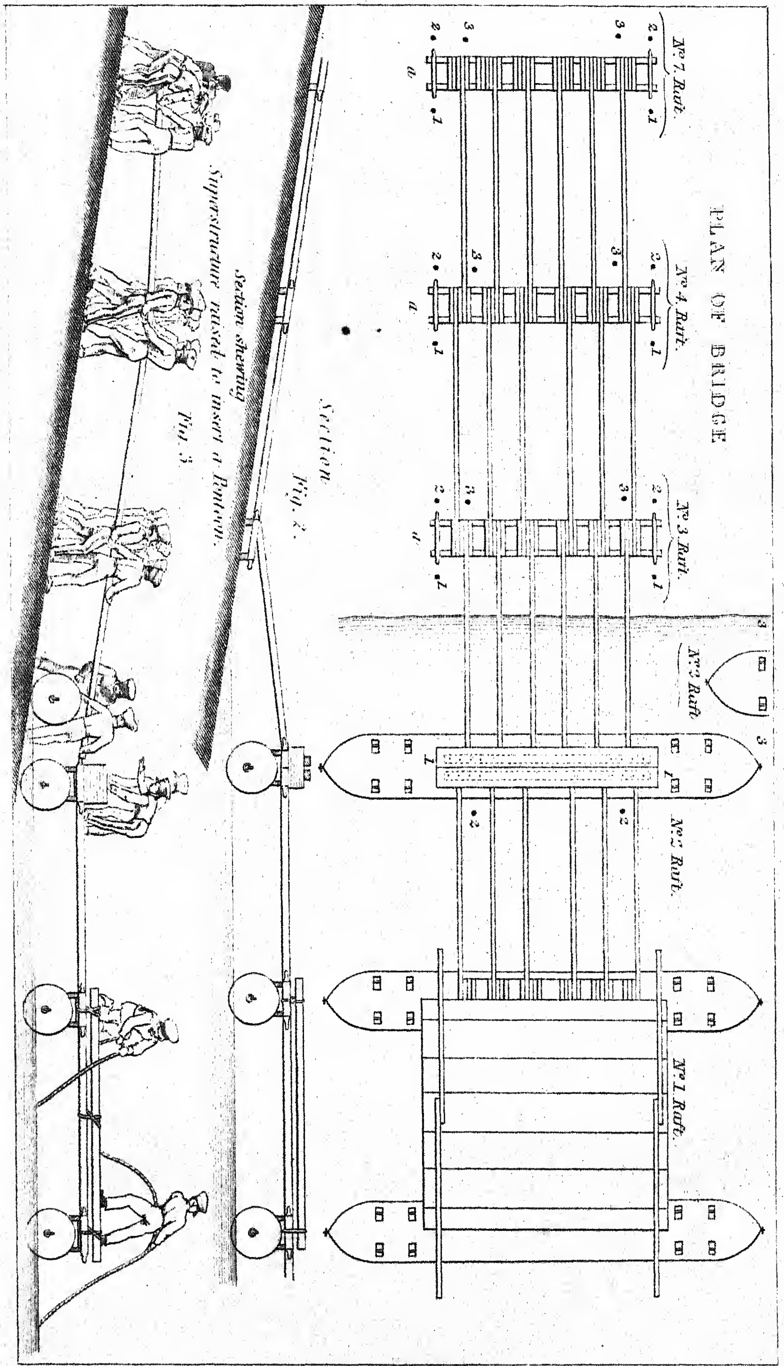
BLANSHARD'S LARGER BRIDGE.

Detailed Plan of the Raft.



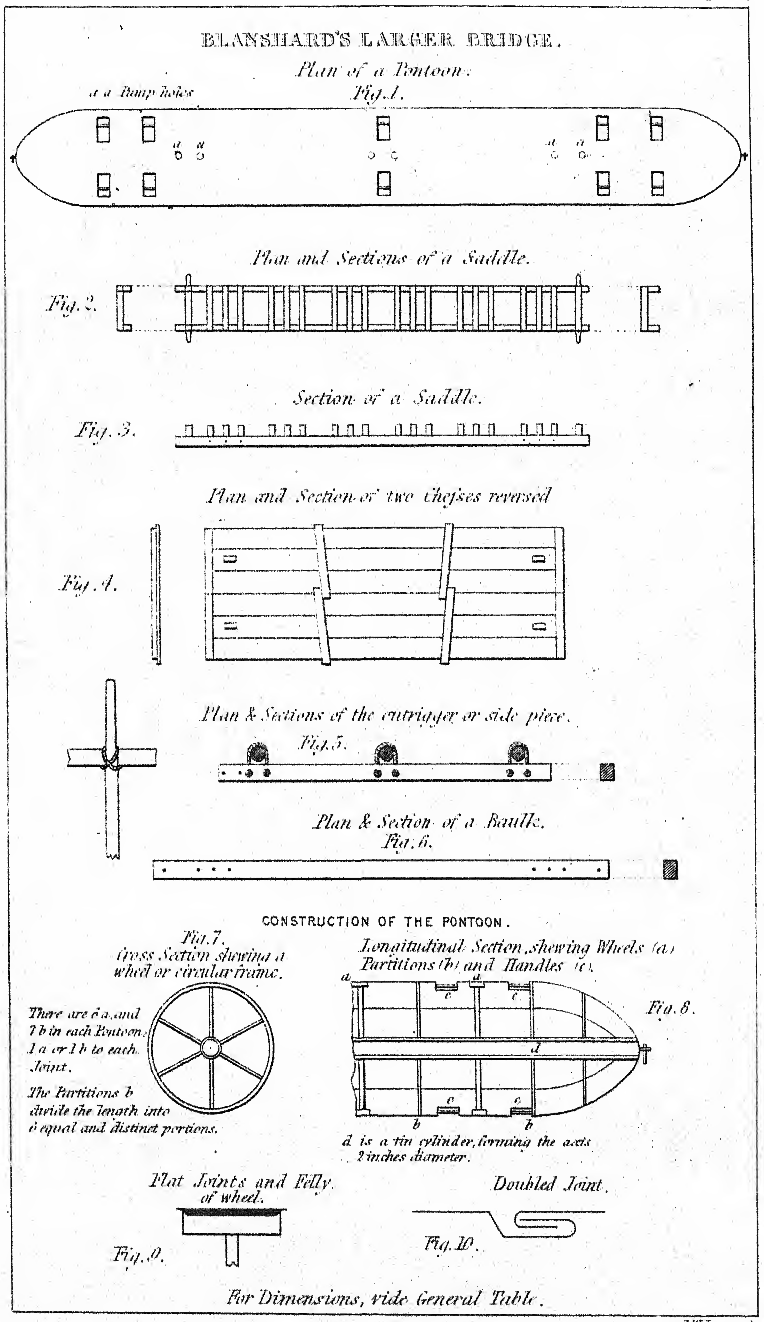
J. W. Lowry fc.

John Weale, 59, High Holborn, 1844.



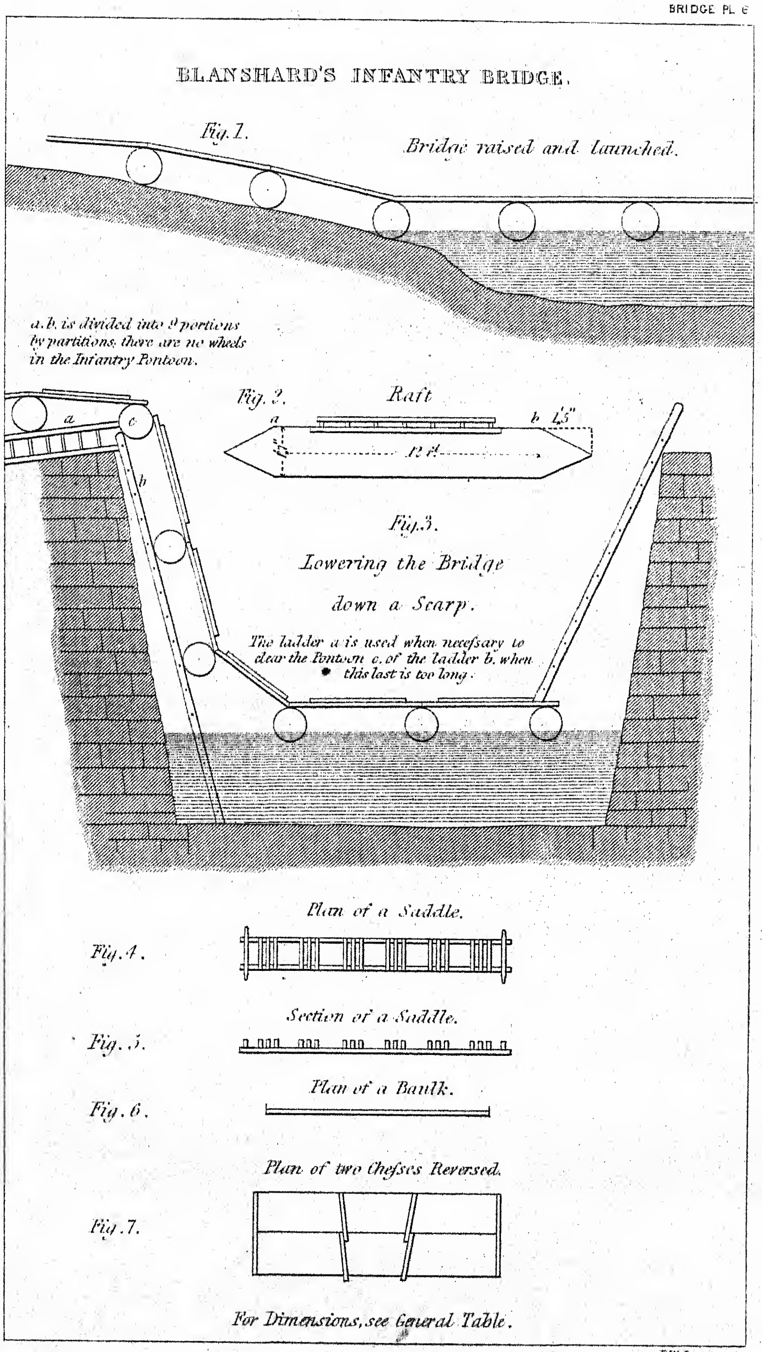
J.W. Lowry sc.

John Weale, 59, High Holborn, 1844.



J. W. Lowry, fc.

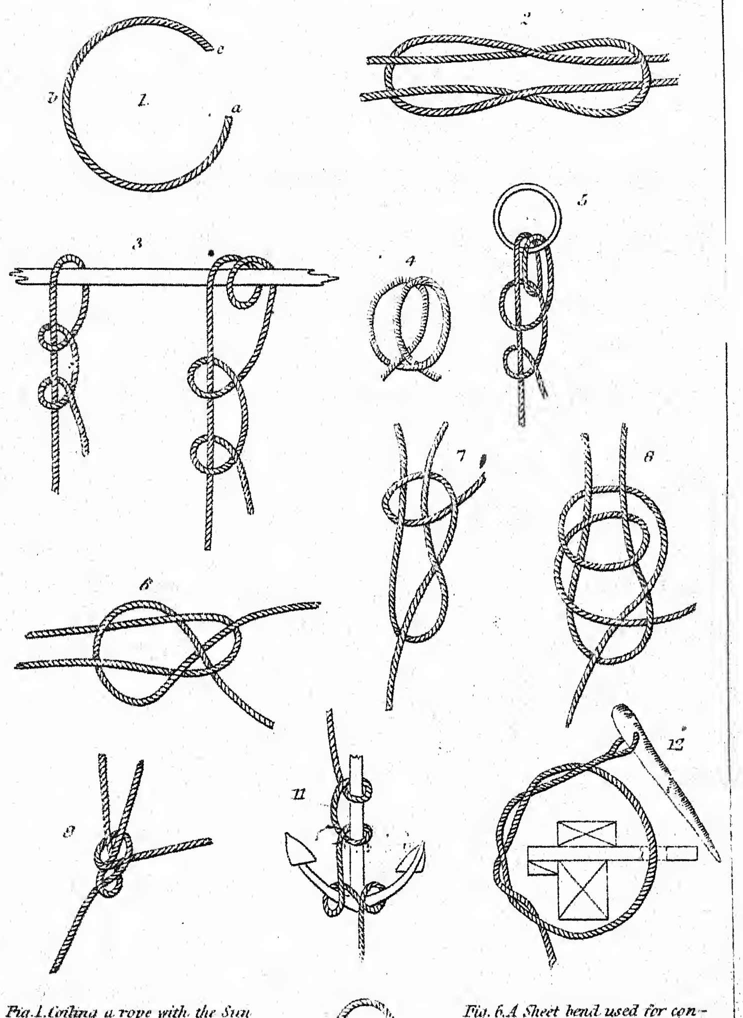
John Weale, 59, High Holborn, 1844.



J. W. Lowry, fc.

London. John Weale. 1844.

BENDS, & KNOTS, USED IN PONTOONING.



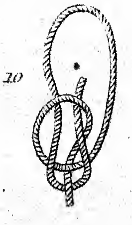


Fig. 1. Coiling a rope with the Sun commencing at a and continuing in the direction a. b. c.

Fig. 2. A reef knot used for making fast the ends of lashings.

Figs. 3. & 4. A clove hitch used for making fast breastlines, painters, and ends of ropes.

Fig. 5. A Fisherman's bend used for fixing the Cables to the Anchors, and the buoylines to the buoys.

Fig. 6. A Sheet bend used for connecting two Cables.

Figs. 7. 8. & 9. A double Sheet bend also used for connecting 2 Cables.

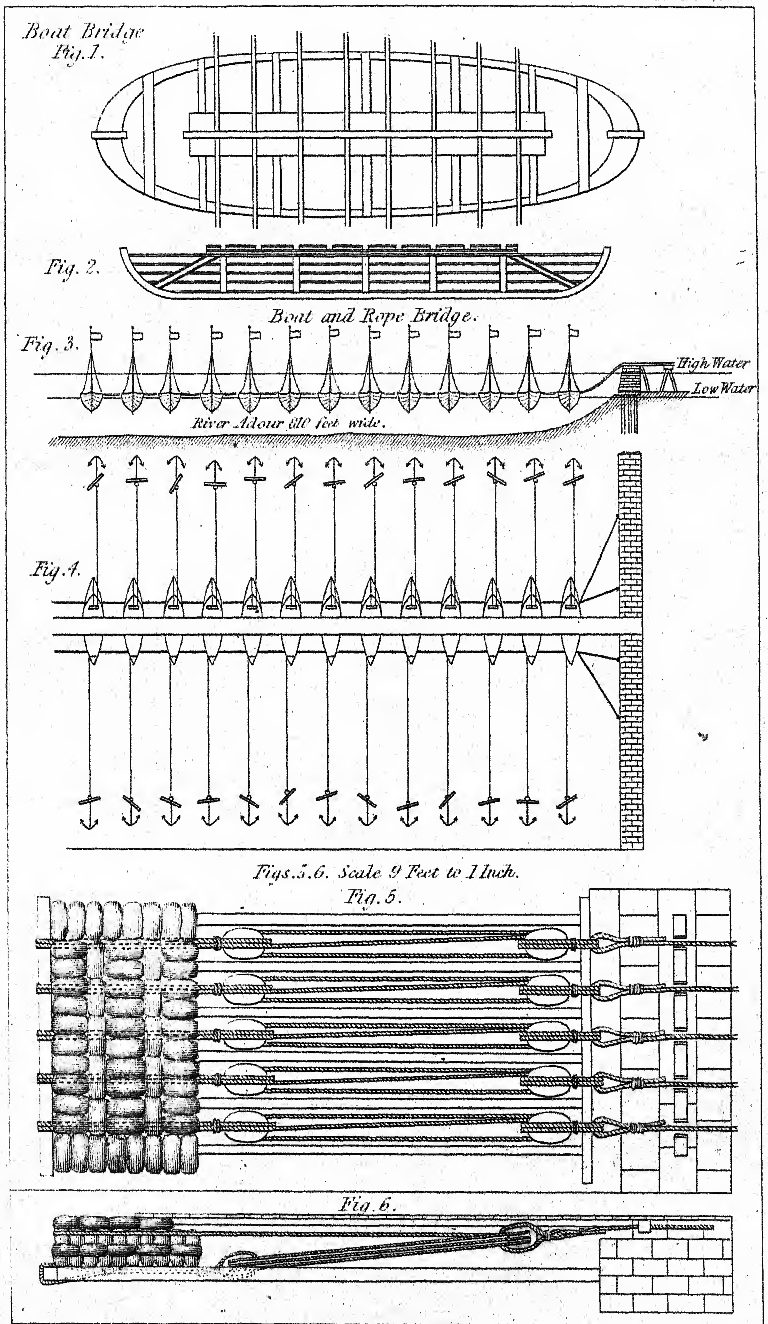
Fig. 10. A Bowline knot serves to throw over a post to haul on.

Fig. 11. The buoy rope bend is used for fixing buoylines to anchors.

Fig. 12. Method of Racking down the Chesses to the Baulks.

J. W. Lowry fc.

John Weale, 59, High Holborn, 1841.

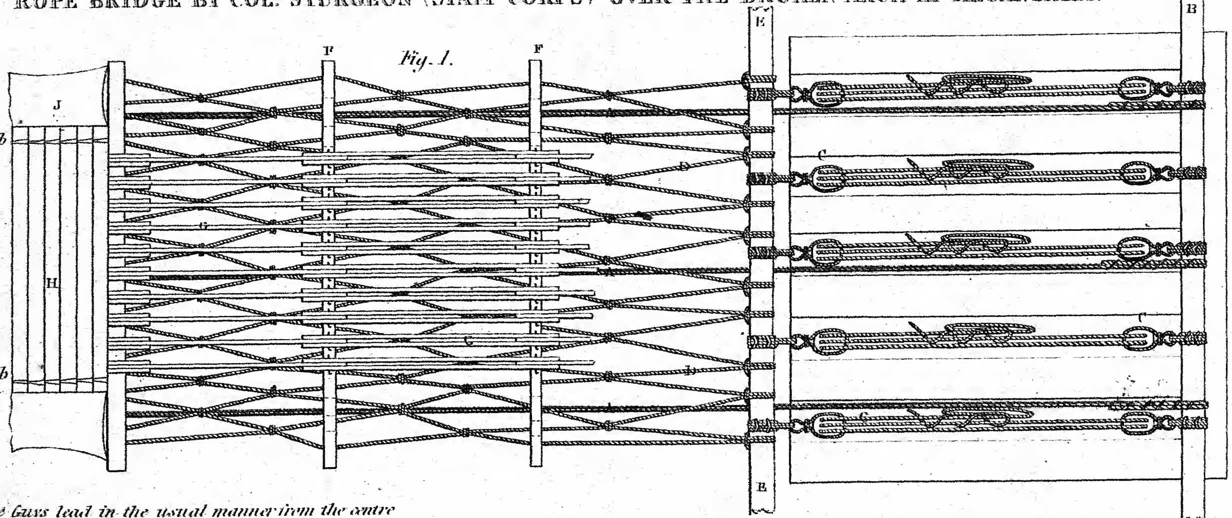


J. W. Lowry fc.

John Weale, 59, High Holborn, 1844.

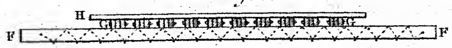
ROPE BRIDGE BY COL. STURGEON (STAFF CORPS) OVER THE BROKEN ARCH AT ALCANTARA.

Fig. 1.



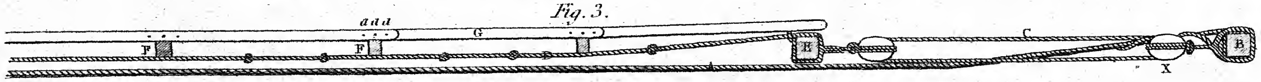
The Guys lead in the usual manner from the centre of the sides of the Bridge, to about 100 feet above and below them, on the Banks.

Fig. 2.



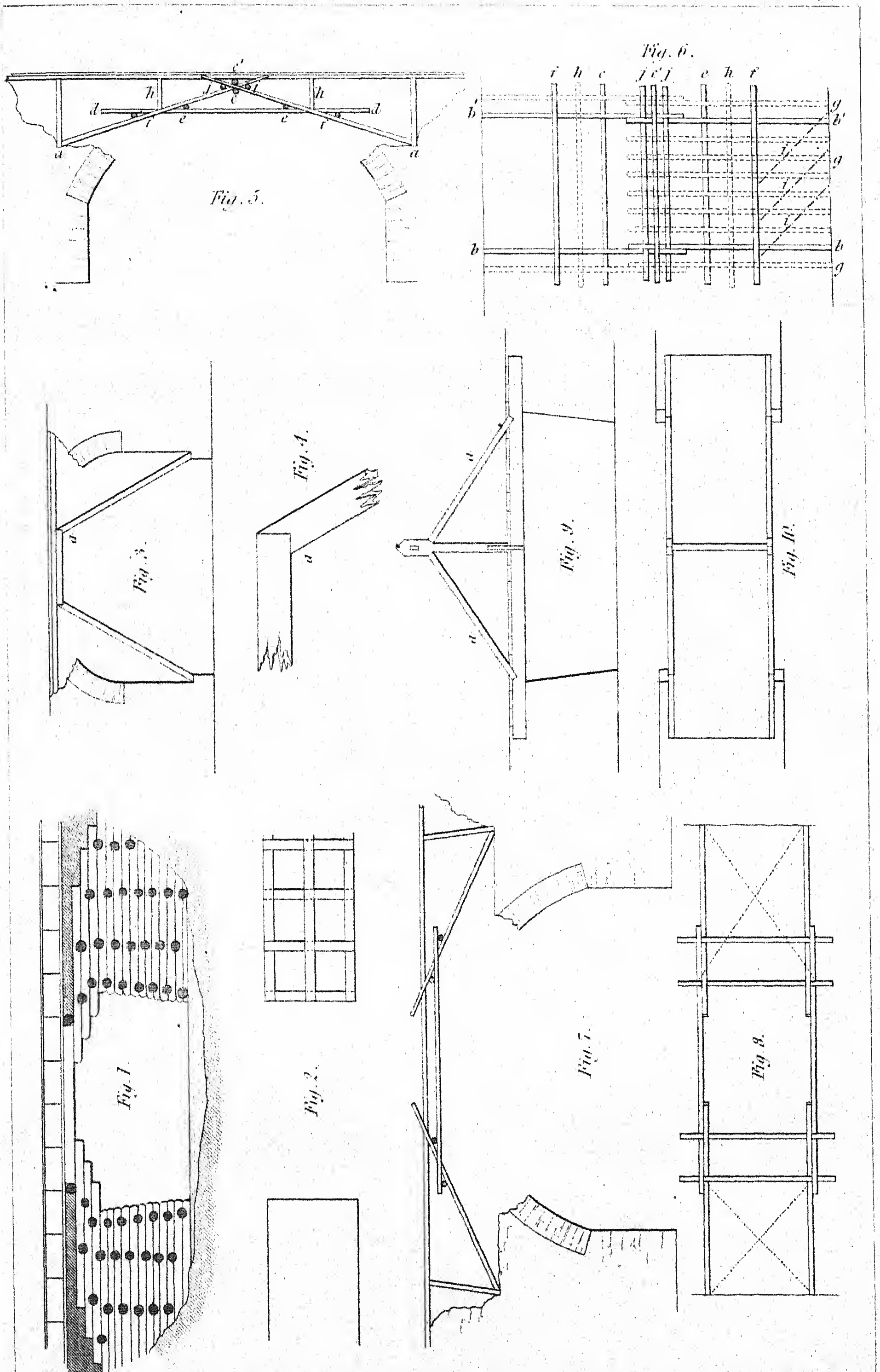
For dimensions, see General Table.

Fig. 3.



J. W. Lowry fc.

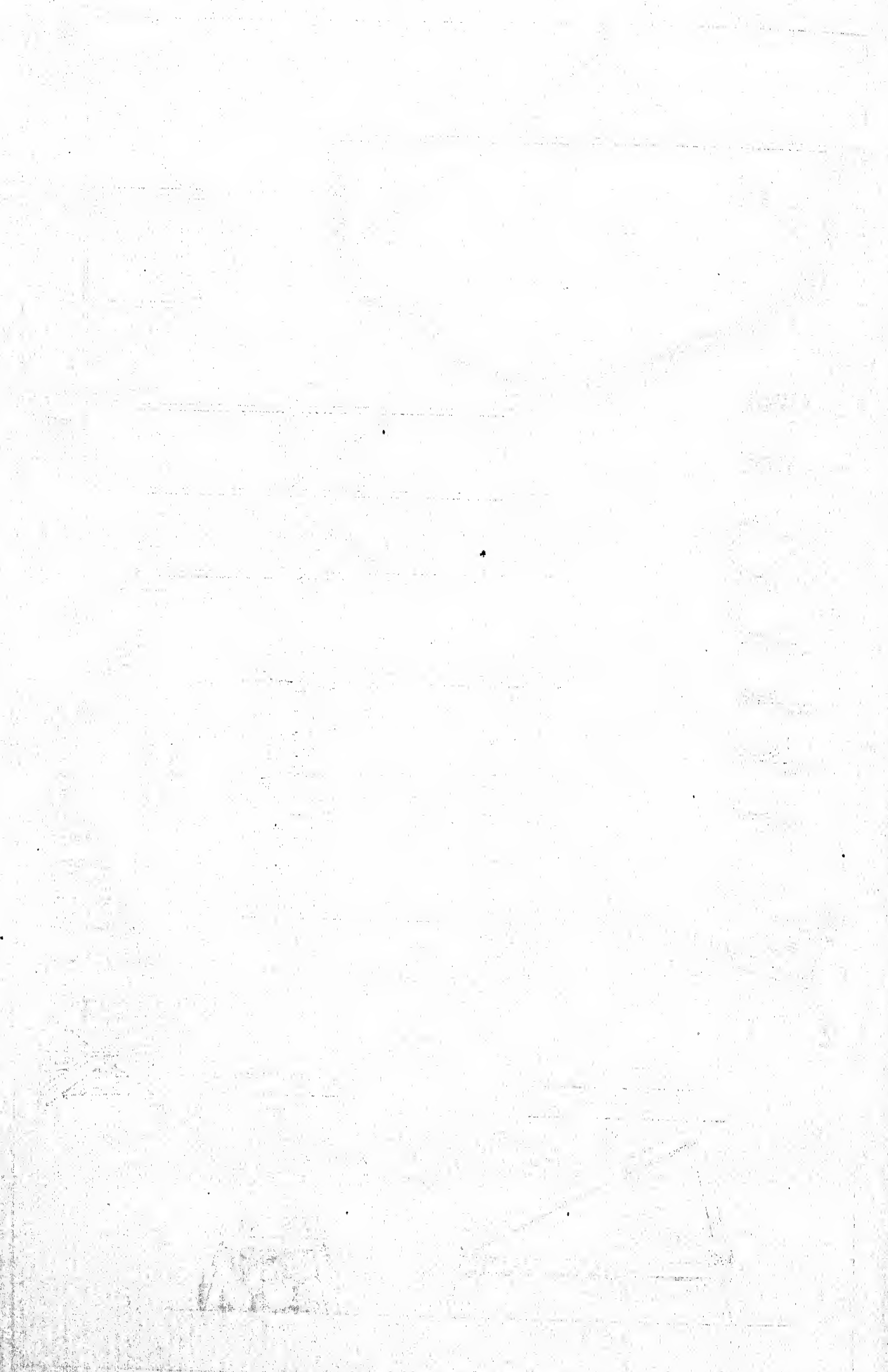
John Weale, 59, High Holborn, 1844.

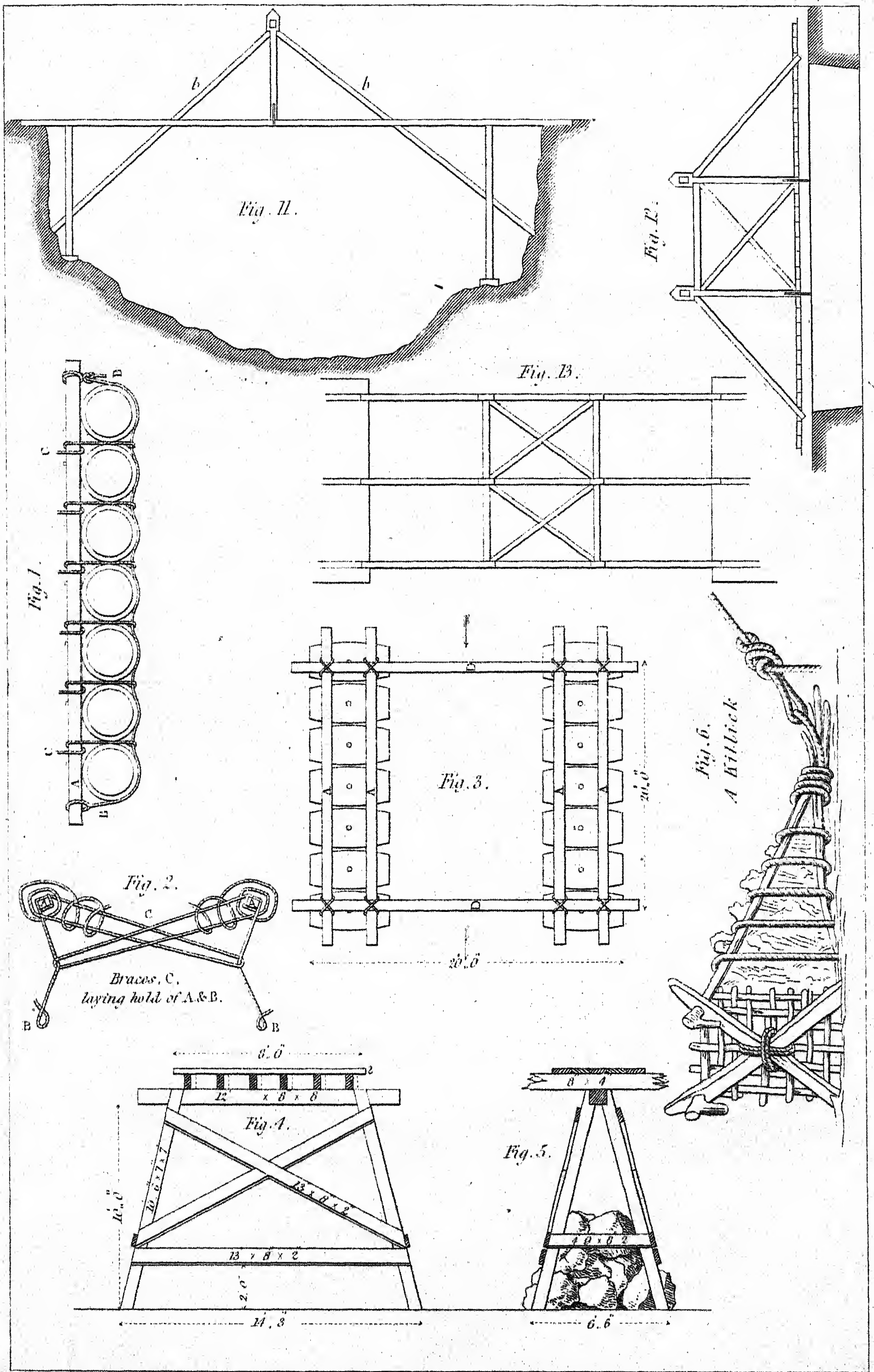


R. J. N. del.

J. W. Lowry fc.

John Weale, 59, High Holborn, 1844.





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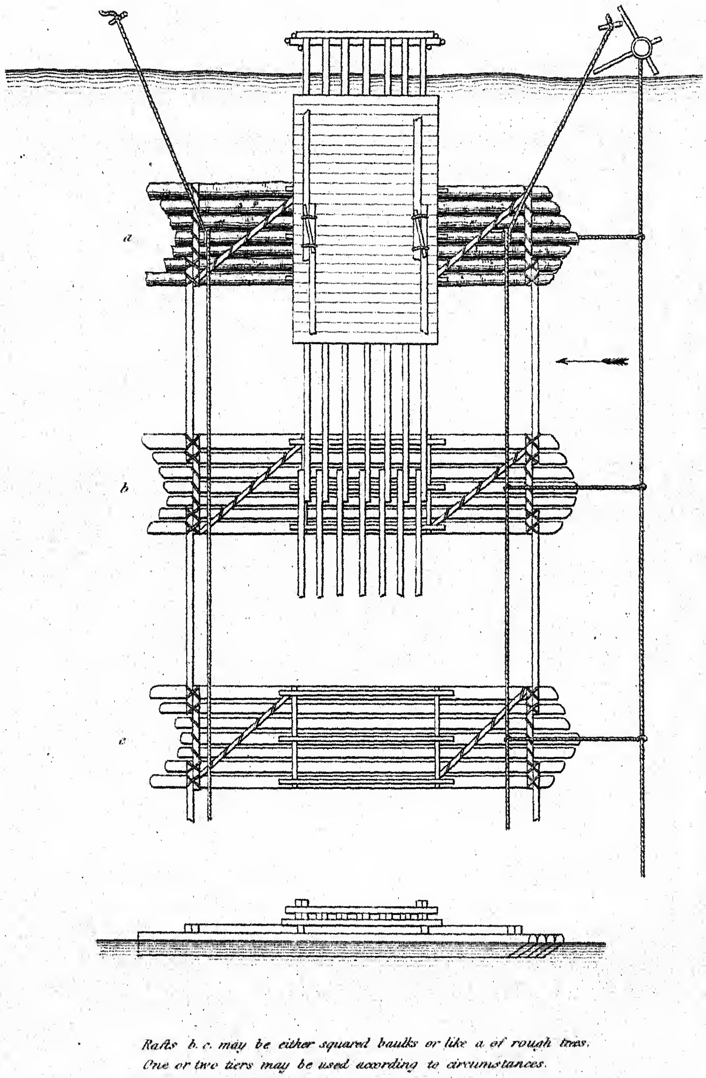
J. W. Lowry fc.

John Weale 59 High Holborn 1844.

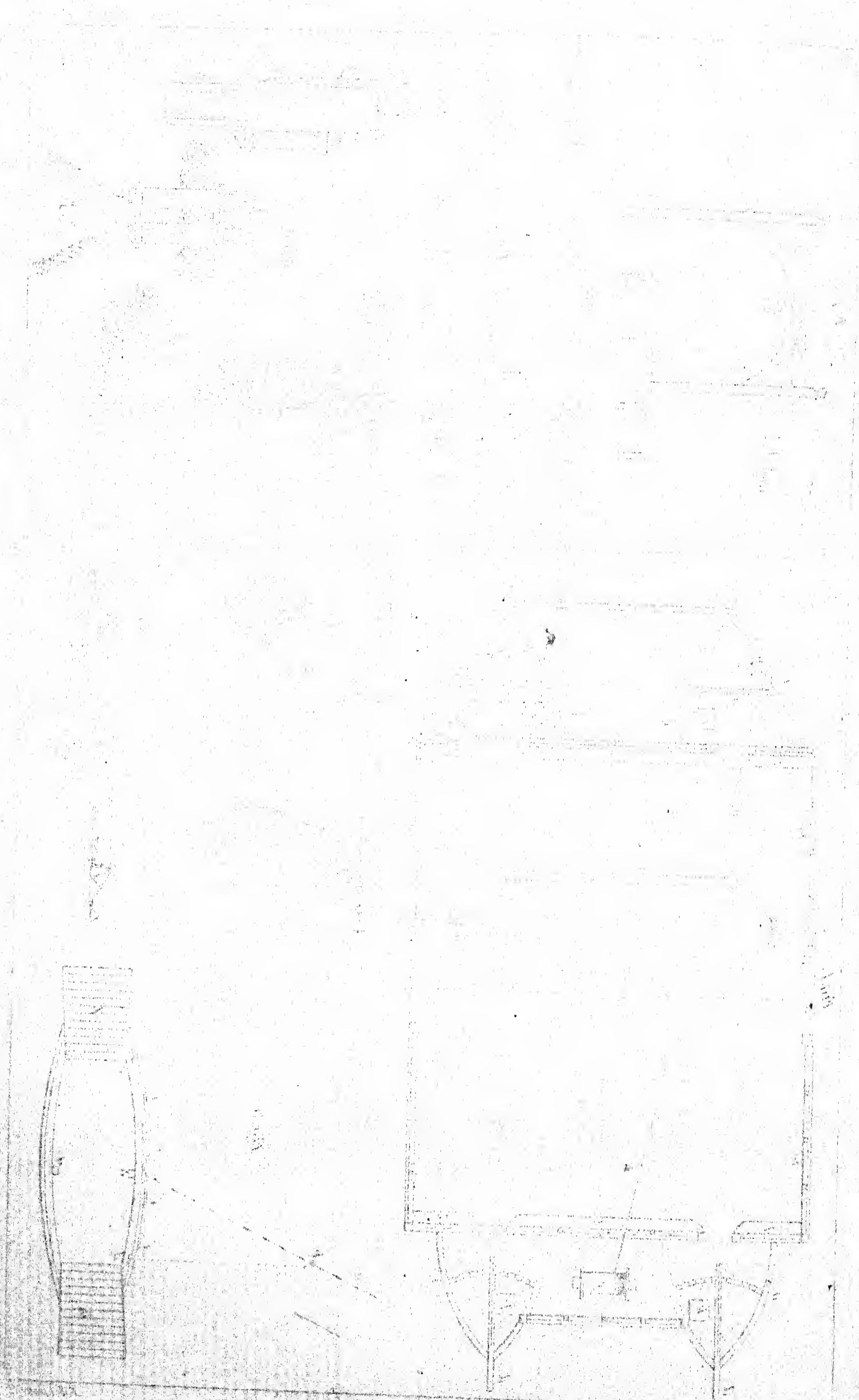
RAFT BRIDGE.

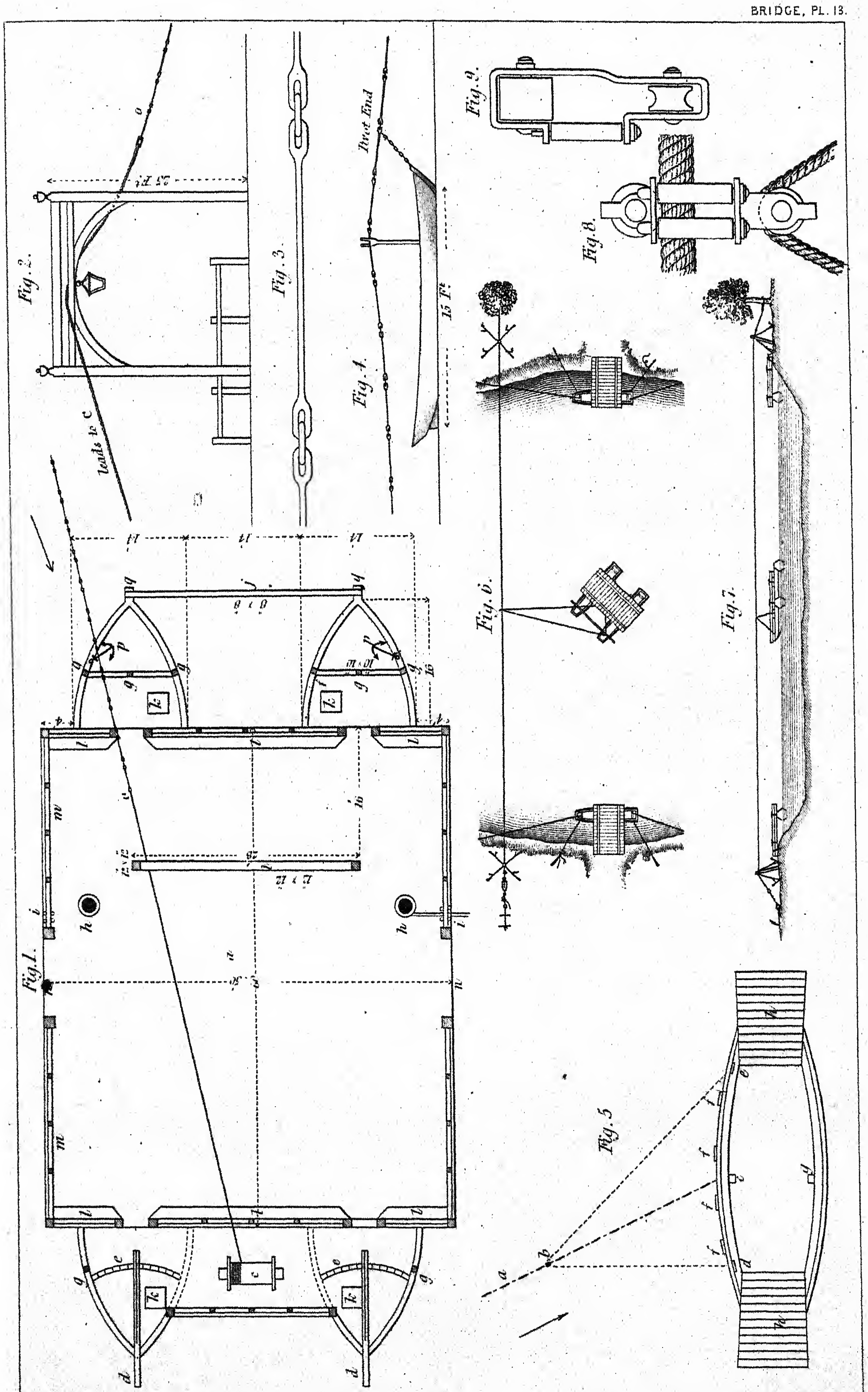


Rafts b. c. may be either squared baulks or like a of rough trees.
One or two tiers may be used according to circumstances.

J. W. Lowry, sc.

John Weale 59, High Holborn, 1844.

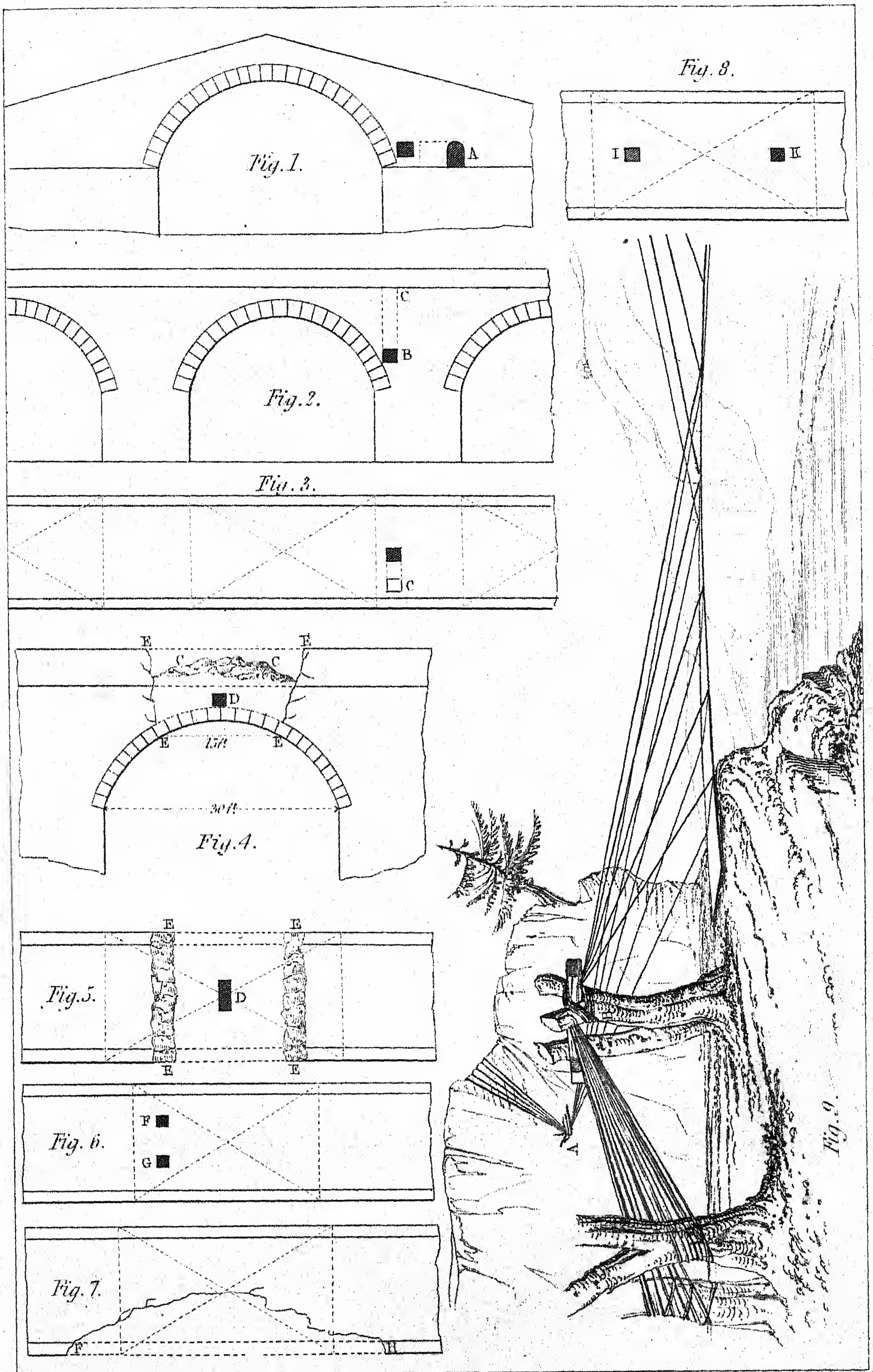




R.J.N. del.

J.W. Lowry fc.

John Weale 59 High Holborn 1844.



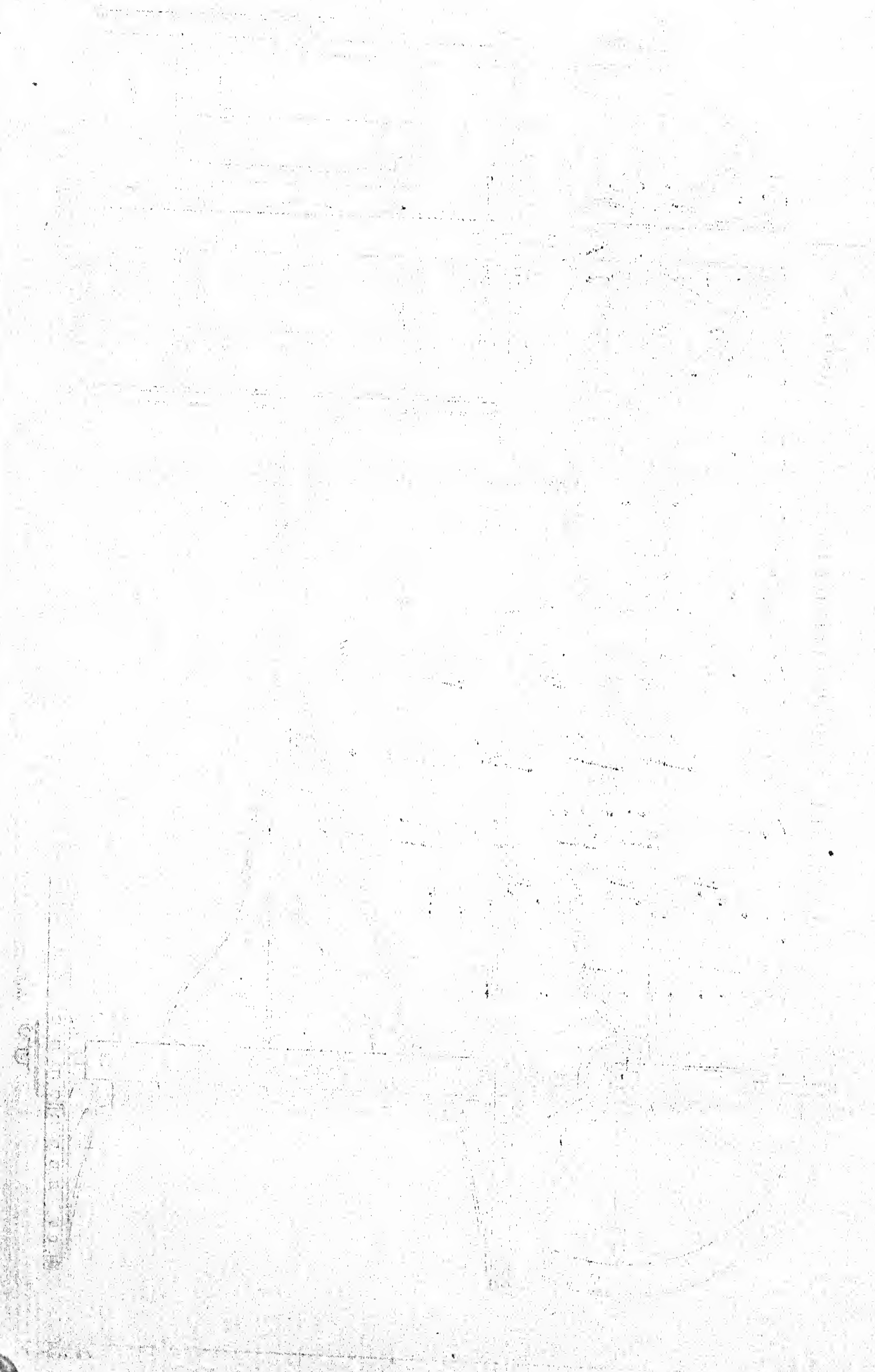
R. J. N. del.

J. W. Lowry fc.

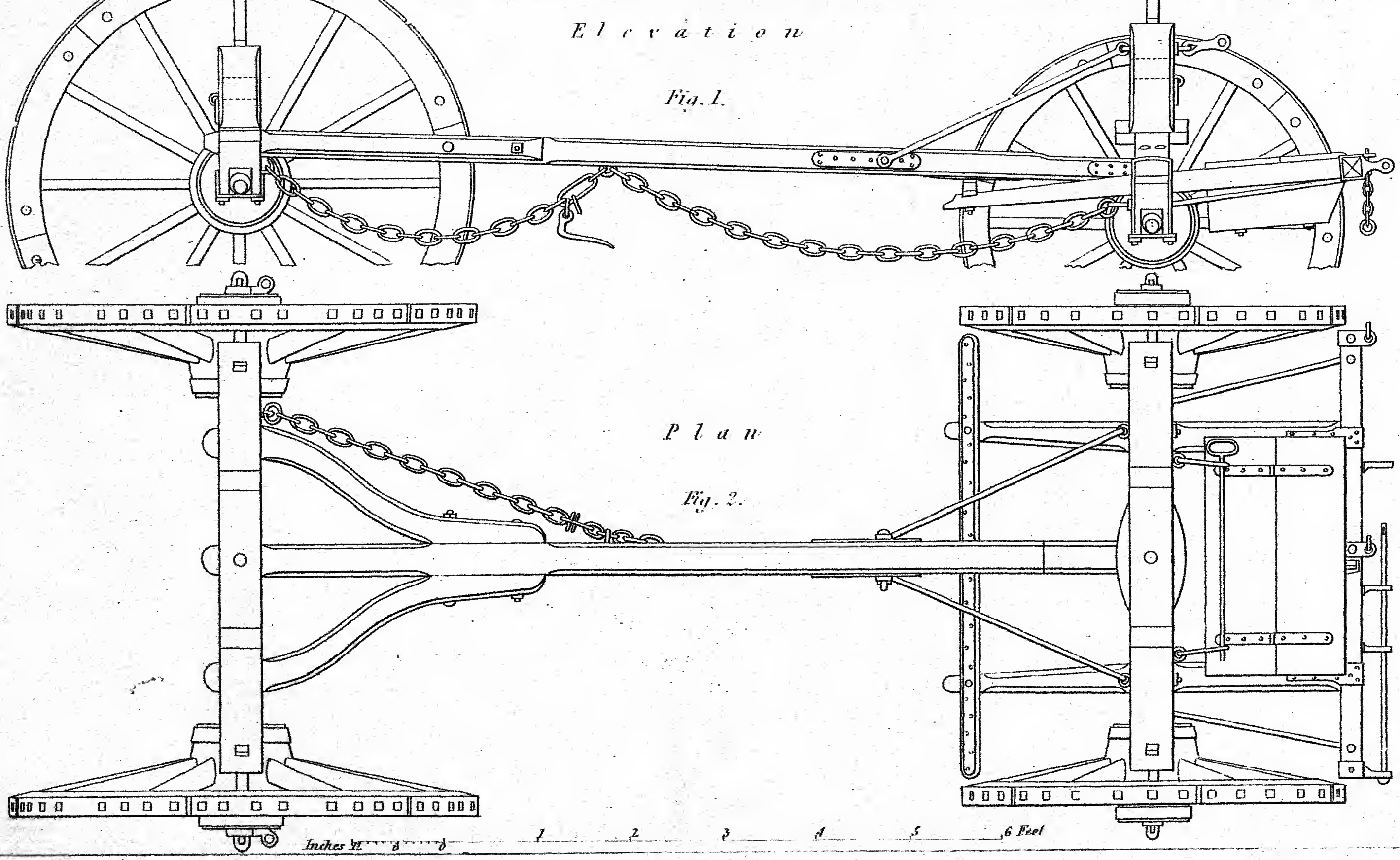
John Weale, 59, High Holborn, 1844.

J.W. Lowry fc.

London, John Weale 59 High Holborn 1844.



BLANSHARD'S LARGE CYLINDER PONTOON WAGGON.



T. Hodgson del. Serg.t Royal Artillery.

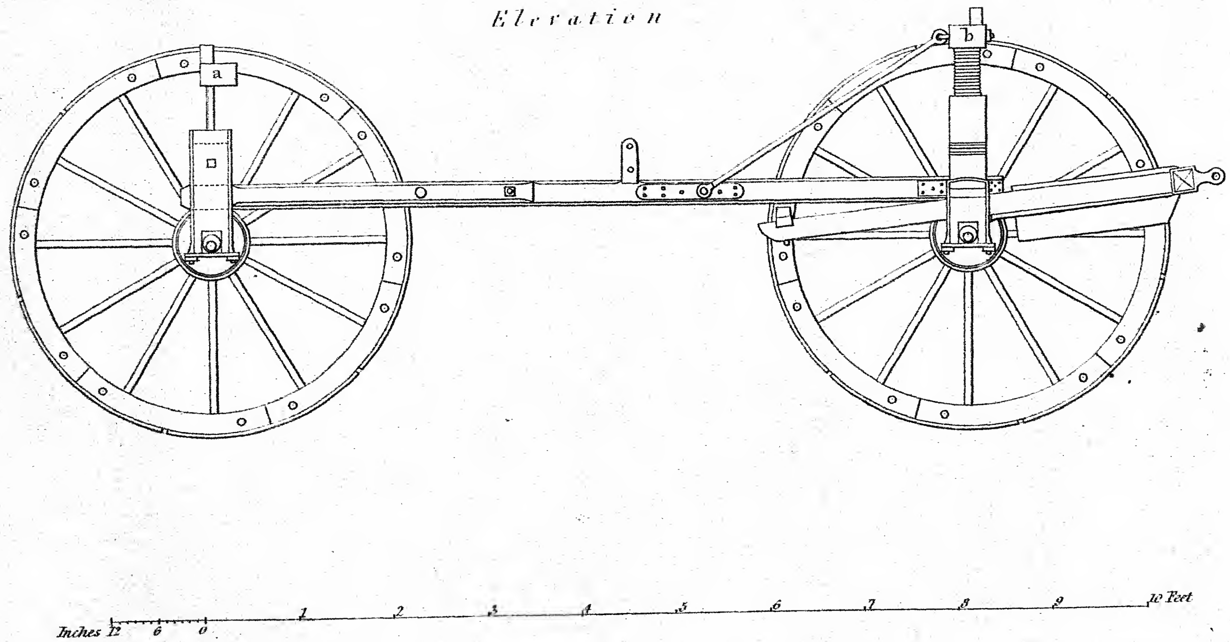
J. W. Lowry fc.

John Weale, 59, High Holborn, 1845.

BLANSHARD'S SMALL CYLINDER PONTOON WAGGON.

a *Height at which rear bolster stands when the box and chesses are packed.*
b *Is 3 higher than* a.
Pontoons lie on the saddles.

Elevation



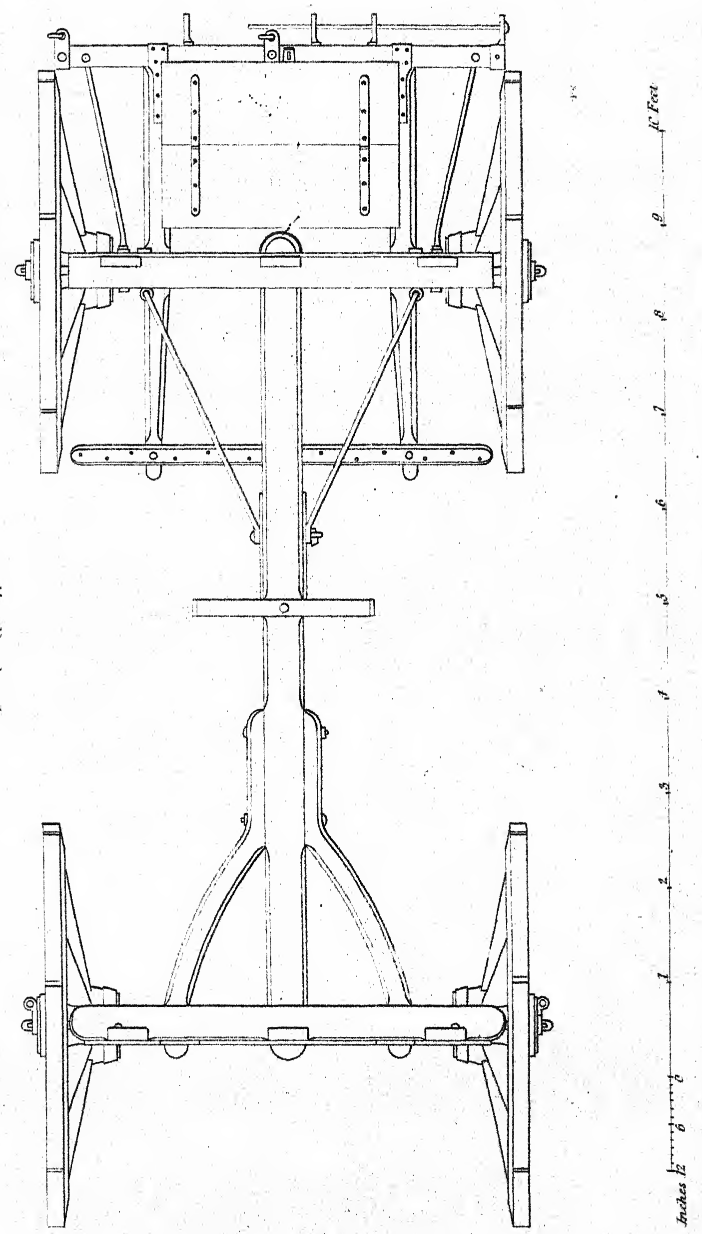
T. Hodgson del.
Serg^t. Royal Artillery.

J. W. Lowry sc.

John Weale 59 High Holborn 1845.

BLANSHARD'S SMALL CYLINDER PONTOON WAGGON.

Plan



T. Hodgson del.
Serg.t Royal Artillery.

J.W. Lowry fc.

John Weale, 59, High Holborn, 1845.

When there was time, these mines were loaded with all the precautions commonly used, viz. the powder in a box, and the saucisson in an auget; and when to lay any time, the box and auget were pitched, and covered with straw, tarpaulin, &c., to preserve the ammunition dry. When pressed for time, and without the proper articles, the powder was lodged in the barrels it was brought in, or laid in a tarpaulin, or in bags; and the saucisson was laid without an auget, but with care, that the stones or rubbish should not choke it. The mine was lighted by a piece of portfire tied into the end of the saucisson.*

Saucisson is so very easily made and carried, and so advantageous, that latterly we never failed having it with us; in our first mines, indeed, for want of it, we cut off the ends of portfires diagonally, and tied them together to pieces of stick the length necessary for train; but such a contrivance is very bad, and owing to it Lieut. Davy was killed on Sir John Moore's retreat, the mine exploding the instant he lighted it, probably from the fire of the composition dropping down to the powder; for which reason, the end portfire should be laid horizontally, and a little clay round it will give additional security.

A small hollow, round the powder in a mine, will increase its effect.

DEMOLITION OF WOODEN BRIDGES.

To destroy Wooden Bridges, powder was sometimes used and applied to the most important supports in the arch, according to its construction; but as there is no other resistance than the air, the quantity of powder should be large: 90 pounds have blown down a strong wooden arch.

The common and best mode with a wooden bridge is to lay the planking bare, and to light a large fire upon it, over the piles forming the piers, which will then burn to the water's edge, if left alone: but this will not do if the enemy cannot be kept from gaining possession of the bridge for at least twelve hours after the fire is lighted.

BUFFALO.—Generally speaking, the Buffalo is seldom or ever employed for military purposes, being too slow, and impatient of heat.

BULLOCK.—In India the Bullock is used in drawing heavy guns, ammunition, and stores of every description.

It is likewise much used in heavy draught at the Cape, in trains ('spans') of from six to twenty, according to the nature of the road or work. It is said, there, that an ox can exist without water for four days; much less endurance gives it immediate preference, for the above duties, to the more sensitively-constituted horse, however inferior in speed and spirit. It will plod on unweariedly at from 2 to 2½ miles per hour, drawing from 3 to 4 cwt., exclusive of the long narrow waggon, over the roughest tracks conceivable, often more like the bed of a torrent than a road.

A serious item of consideration, in estimate of Ox establishments, lies in the heavy casualties to which, when over-worked and ill-fed, they are liable, from causes unavoidable, in the very country where the animal is most valuable.

As a Commissariat item of provision, the Devonshire Bullock averages from 4½ to 5½ cwt., net, carcass. R. J. N.

* Bickford's fuzes will, in many instances, prove a valuable improvement on the saucisson or powder hose; especially in exploding charges under water, as well as the voltaic battery and prepared wires.

CABLE, CHAIN.

SIZES, WEIGHTS, AND STRENGTHS OF CHAIN CABLES* AND COMMON CHAIN.

Chain Cable.								Common Chain.			
Denomination from diameter of iron of the link, in inches.	Weight of stay pins.	Required Weight of cable. 1 fathom.	† Complete cable of 100 fathoms.			Strengths. ‡ Proof required.	Ultimate strength.	Denomination from diameter of iron of the link, in inches.	Weight of 1 fathom.	Strengths. ‡ Proof required.	Ultimate strength.
in.	oz.	lbs.	cwt.	qrs.	lbs.	tons.	tons.	in.	lbs.	tons.	tons.
$2\frac{1}{4}$	40	272	243	,,	,,	$91\frac{1}{8}$	125·9	$1\frac{5}{8}$	155·7	31·6	73
$2\frac{1}{8}$	$33\frac{1}{2}$	242·75	216	3	,,	$81\frac{1}{4}$	112·3	$1\frac{1}{2}$		27	62·3
2	28	215	192	,,	,,	72	99·5§	$1\frac{7}{16}$		24·7	57·4
$1\frac{7}{8}$	23	189	168	3	,,	63	92·8§	$1\frac{3}{8}$		22·6	52·8
$1\frac{3}{4}$	$18\frac{3}{4}$	164·5	147	,,	,,	$55\frac{1}{8}$	74·1§	$1\frac{5}{16}$		20·6	48·4
$1\frac{5}{8}$	15	141·9	126	3	,,	$47\frac{1}{2}$	66·5	$1\frac{1}{4}$		18·8	44·1
$1\frac{1}{2}$	$11\frac{4}{5}$	120·9	108	,,	,,	$40\frac{1}{2}$	59·5§	$1\frac{3}{16}$		17	40·1
$1\frac{3}{8}$	9	101·6	90	3	,,	34	48·5	$1\frac{1}{8}$	74·8	15·3	36·3
$1\frac{1}{4}$	$6\frac{4}{5}$	84	75	,,	,,	$28\frac{1}{2}$	38·5	$1\frac{1}{16}$		13·6	32·7
$1\frac{1}{8}$	5	68	60	3	,,	$22\frac{3}{4}$	29·5§	1	64·9	12·0	29·3
1	$3\frac{1}{2}$	53·7	48	,,	,,	18	24·3§	$\frac{15}{16}$	56	10·5	26·1
$\frac{7}{8}$	$2\frac{1}{3}$	41·1	36	3	,,	$13\frac{3}{4}$	21·1§	$\frac{7}{8}$	45	9·1	23·1
$\frac{3}{4}$	$1\frac{1}{2}$	30·2	27	,,	,,	$10\frac{1}{8}$	13·5§	$\frac{13}{16}$	40	7·9	20·4§
$\frac{11}{16}$	$1\frac{1}{8}$	25·4	22	2	21	$8\frac{1}{2}$	11·4	$\frac{3}{4}$	34·5	6·8	17·3
$\frac{5}{8}$	$\frac{9}{10}$	21	18	3	,,	7	9·5§	$\frac{11}{16}$	29	5·6	14·6
$\frac{9}{16}$	$\frac{2}{3}$		15	,,	21	$5\frac{1}{2}$	,,	$\frac{5}{8}$	25·3	4·6	12 §
$\frac{1}{2}$	$\frac{5}{10}$	13·4	12	,,	,,	$4\frac{1}{2}$	6·0	$\frac{9}{16}$	20	3·8	9·7
$\frac{7}{16}$	$\frac{3}{10}$		9	,,	21	$3\frac{1}{2}$	,,	$\frac{1}{2}$	15·8	3·0	7·7
								$\frac{7}{16}$	10·6	2·3	5·9
								$\frac{3}{8}$	8·3	1·6	4·3
								$\frac{5}{16}$	5·8	1·1	3·0
								$\frac{1}{4}$	3·9	·75	1·9
								$\frac{3}{16}$		·42	1

STRENGTH OF PATENT WIRE ROPE.

Circumference.	Maker.	Breaking weight.
Inches.		Tons.
$4\frac{1}{8}$	Kuper and Co.	20
$3\frac{3}{4}$	Ditto.	$13\frac{1}{2}$
$3\frac{1}{2}$	Andrew Smith.	$14\frac{1}{2}$
$3\frac{1}{2}$	Ditto.	$16\frac{1}{2}$
$3\frac{1}{8}$	Kuper and Co.	$10\frac{1}{2}$
$2\frac{5}{8}$	Ditto.	$7\frac{1}{2}$
$2\frac{3}{8}$	Ditto.	7
$1\frac{1}{2}$	Ditto.	$2\frac{3}{4}$
1	Ditto.	$1\frac{1}{2}$
$\frac{3}{4}$	Ditto.	1

* From documents supplied by Capt. Sir Wm. Denison, R.E., from official records. The strengths were tested by the hydraulic press at Woolwich, capable of giving a pressure of 120 tons. At that place, great pains are taken to obviate the chances of error to which these machines are liable, —by frequently testing the unit of power.

† Weight of 100 fathoms of cable in 8 lengths, including 4 swivels and 8 joining shackles.

‡ Estimated at 630 lbs. per $\frac{1}{8}$ inch, in diameter, of the iron of the link.

§ Ascertained by altogether 67 actual trials.

As an accompaniment to the preceding Table, the Government specification for Chain Cables is appended. In the Plates will be found approved plans for shackles, couplings, &c., &c.

The weights given are the minimum allowed; and between this and the maximum the Contractor is allowed a latitude of $\frac{1}{15}$ in the $2\frac{1}{4}''$ chain, and of $\frac{1}{20}$ in all the rest.

The length of a link is 6 diameters of the iron used, and the breadth 3·6 diameters: thus the length in a $2\frac{1}{4}''$ chain is $13\frac{1}{2}''$, and the breadth 8·1.

It is to be observed that chains with stay pins are not so applicable to machinery as those without; in the Ferry between Devonport and Torpoint, most of the pins in the ground-chain flew out in a few weeks, as they passed at a sharp turn round the wheels.

SPECIFICATION FOR CHAIN CABLES.

The Iron Chain Cables are to be made in $12\frac{1}{2}$ fathoms lengths, with one swivel in the middle of every other length, and one joining shackle to each length, and of the weight specified in the Table.

The several sizes of Chain Cables being distinguished by the diameter of the iron of their common links, this diameter forms the unit of the scale of dimensions in the accompanying drawings, (see Plate,) by which the dimensions of the various parts of the cables of all sizes, and of the articles to be connected therewith, are to be proportioned. Thus, the length of a common link is to be 6 diameters, and its breadth 3·6 diameters, of its iron; and the length of an end link is to be 6·5 diameters, its breadth 4 diameters, and the substance of its iron 1·2 diameter, of the iron of a common link; and so on for all the parts of cables of all sizes, and articles to be connected therewith, which are to be made as near as practicable to the dimensions shewn by the drawings, or specified herein, or in the accompanying Table.

The diameter or transverse section of the iron of the links, and of the various parts of the swivels, shackles, and other articles to be connected with the cables, is not to be less, taking the mean of the greatest and least dimension at any one section, than that specified herein, or in the Table, or shewn by the drawings. Also the length of the various links, swivels, shackles, and other articles, is not to be more than $\frac{1}{10}$th of the diameter of the iron of the common links over, nor their width more than $\frac{1}{10}$th such diameter over or under that specified or indicated as above mentioned.

The stay pins are to be of cast iron not exceeding the weights specified in the Table, and are not to be wider at their ends than the diameter of the iron of the links in which they are inserted, nor at their middle part than $\frac{6}{10}$ths of such diameter, meaning longitudinally, of the links.

Both the end links of every length of a cable, as well as those of the mooring swivels, splicing tails, and splicing shackles, are to be made parallel-sided, without stay pins, and with the substance of their iron $\frac{2}{10}$ths of a diameter larger than the diameter of the iron of the common links of the cable to which they belong, as shewn by the drawings, and so as to admit the joining shackles to be inserted or taken out of them in connecting or disconnecting any two lengths of the same, or of different cables of the same size, by either end; also to receive the bolt of the large shackle for connecting any length of cable of the same size, by either end, with the anchor.

The enlarged links connected with the end links, and with each end of the swivels, are to be made $\frac{1}{10}$th part larger in the diameter of their iron than the common links of the cable they belong to, and with a stay pin in proportion.

The splicing tails of the different sizes, for connecting Iron and Hempen Cables together, are each to consist of one end link, without a stay pin, followed by one enlarged link, fourteen common links, and then another enlarged link, all with stay pins,

and all the before-mentioned links are to be of the same size as those of the Iron Cable, to which the splicing tail is to be attached; also of an egg-shaped link, no wider nor longer than necessary, of iron 1 $\frac{3}{10}$ths diameter of that of the common links, connected at its narrow end with the last-mentioned enlarged link, and at its broad end with three short-linked chains (without stay pins) called tails, the first link of each of which, connected with the egg-shaped link, is to be of iron $\frac{8}{10}$ths the diameter of that of the common links. And the remaining links of each tail, about 65 in number, are to diminish gradually in size to iron of ¼ of the diameter of that of the common links before mentioned.

The steel tinned pins for retaining the joining shackle bolts, and the forelocks for the large shackle bolts, are not to follow the exact proportion agreeably to the diameter of the iron of the common links, laid down for other parts of cables; but these articles, as well as the starting, and driving-out punches, are to be made as specified in the accompanying Table.*

R. J. N.

CABLE, HEMP.†—All Rope is specified by its circumference.

The Cables, &c. referred to in the following Table are made with the ordinary machinery hitherto used in the manufacture for the Navy.

The weights and strengths have been collected from different Dockyards; in many instances, in the 4th columns of Cable and Hawser, they have been obtained practically and experimentally; in the remainder they have been computed: in the fifth columns, the strengths are those given by the hydraulic press. All rope and cordage below 3½ inches circumference was proved by dead weight. The strength of one tarred yarn, as the average of 31 experiments, is 147⅗ lbs.: nearly one-half of this, and about one-third of the length, is lost in twisting.

In the manufacture of Cable-laid rope the yarns are divided into nine equal parcels: each part, when twisted to an angle of 37°, is called a *lissum;* three lissums, wrought to the same angle, make one *strand;* and three strands, in like manner, make one cable.

In Hawser-laid ropes the yarns are divided into only three parcels, called lissums or strands; and these, when twisted again, form the Hawser. Hawsers are sometimes laid in four lissums; but under all circumstances, 3, or 4, they contain more yarns than cables of the same size, and are harder laid.

The following reductions in length take place in the above-mentioned stages.

	10-INCH CABLE.			10-INCH HAWSER.		
Yarns,	504	of 152 fathoms.		648	of 152 fathoms.	
Lissums,	9	142	,,	3	142	,,
Strands,	3	118	,,			
Cable,	1	101	,,	1	3-str^d. Hawser, 113	,,
					4 ,, ,, 106	,,

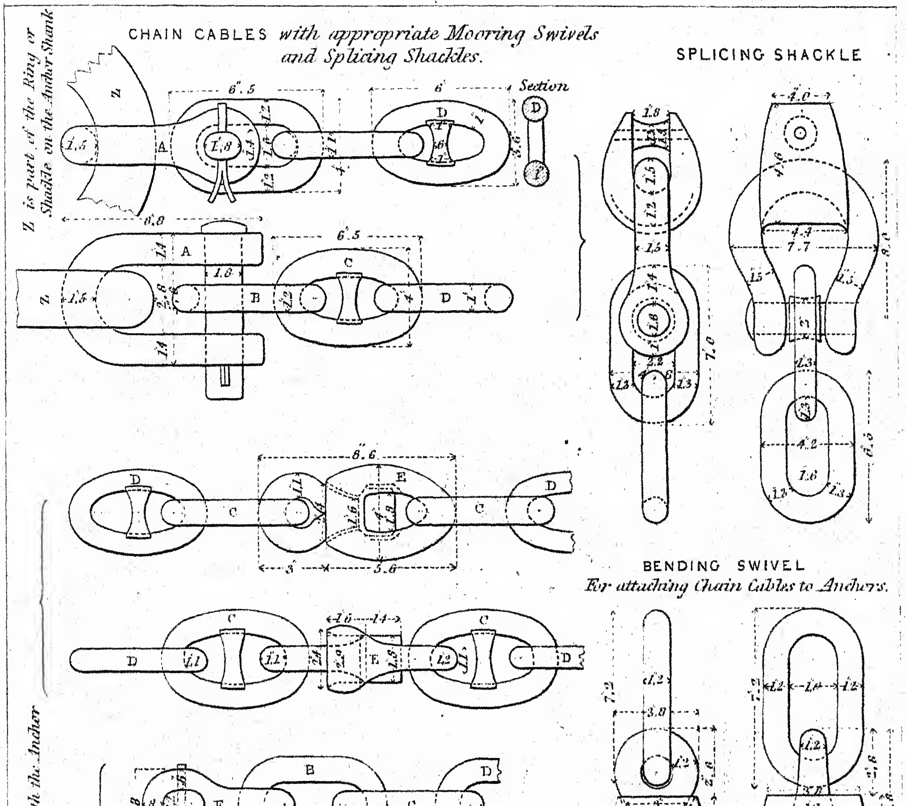
The present price of all cordage is about £40 per ton.

In the following Table, the strength of the 10″ hawser is given at 21 tons; this was from actual experiment, but the hemp for it was hatchelled finer than usual; 20 tons is a fairer average statement.

A discrepancy appears between the two last columns of the 'Cable-laid,' as well as

* For all that is essential see the Plate. In the Table commencing this article, several minutiæ of specification have been omitted, as unnecessary for general purposes.—R. J. N.

† From documents chiefly supplied by Capt. Burgmann, R. E.



This Plate shews the proportions of the different parts of Chain Cables and their appurtenances, in terms of the diameter of the Common Link; thus the diameter of the iron of the Common Link D, is 1; that of B is 1.2: the length and breadth of C, 6.5 & 4 times the diameter of the iron of D as the Unit.

J.W. Lowry fc.

John Weale. 59, High Holborn, 1845.

in 'Hawser-laid,' in which correction has not been attempted, as they are from different and highly respectable authorities. It will be safest, generally, to take about two-thirds of the last column of Cable-laid as the practical strength for that description of rope.

Table of Weights and Strengths of Cables and Hawsers.

Cable-laid.					Hawser-laid.							
	Tarred.					3 or 4-Strand ; Tarred.					3-Strand; White.‡	
Circumference in inches.	Number of yarns.	Weight per fathom.	Strength of cables in tons.	Breaking weight, as obtained by actual trial.*	Circumference in inches.	Number of yarns.	Number of strands.	Weight per fathom.	Strength of hawsers in tons.	Breaking weight, as given by actual trial.†	Number of yarns.	Weight per fathom.
In.	No.	lbs.	Tons.		In.	No.	No.	lbs.	Tons.	Tons.	No.	lbs.
26	3528	139·72	Not ascertained.		12	936	4	34·79	Not ascertained.			
25½	3384	134·01			,,	924	3	32·70				
25	3240	129·16	112·75	103·25	11½	852	4	31·62				
24½	3132	124·03	Not ascertained.		,,	852	3	30·15				
24	2988	118·94	103·00		11	781	4	28·00				
23½	2880	114·05	Not ascertained.		,,	780	3	27·61				
23	2736	109·24	95·00		10½	711	4	26·42				
22½	2628	103·58	91·00	97	,,	708	3	25·06				
22	2520	99·95	87·00		10	642	4	23·84				
21½	2376	94·57	83·00		,,	648	3	22·93	21·00		732	21·59
21	2268	91·07	79·25		9½	573	4	21·27	Not ascertained.			
20½	2160	85·97	75·75		,,	573	3	21·20	18·90		660	19·56
20	2088	82·69	72·00	76·16	9	521	4	19·37	Not as.	24·85		
19½	1980	77·78	68·25		,,	516	3	18·57	17·00		588	17·34
19	1872	74·55	65·00		8½	468	4	17·39	Not ascertained.			
18½	1764	70·00	61·50		,,	468	3	16·56	15·20		528	15·57
18	1656	66·90	58·25		8	416	4	15·45	Not ascertained.			
17½	1584	62·63	55·00	54·45	,,	408	3	14·67	13·40	22·03	468	13·81
17	1476	59·68	52·00		7½	364	4	13·50	Not ascertained.			
16½	1404	55·67	49·00		,,	360	3	12·89	11·80		408	12·03
16	1332	52·86	46·00		7	313	4	11·61	Not ascertained.			
15½	1224	49·13	43·25		,,	312	3	11·23	10·30		360	10·61
15	1152	46·46	40·50	42·55	6½	261	4	9·70	Not ascertained.			
14½	1098	42·98	37·75		,,	264	3	9·68	8·90		300	8·84
14	1008	40·47	35·25		6	226	4	8·39	Not ascertained.			
13½	936	37·25	32·75		,,	228	3	8·25	7·60	11·66	264	7·78
13	864	34·90	30·25		5½	191	4	7·09	Not ascertained.			
12½	792	31·93	28·00	31·4	,,	192	3	6·93	6·40		216	6·37
12	756	29·73	26·00		5	157	4	5·82	Not ascertained.			
11½	684	27·02	23·75		,,	156	3	5·73	5·30		180	5·10
11	612	24·98	21·75		4½	130	4	4·83	Not ascertained.			
10½	576	22·52	20·00		,,	130	3	4·64	4·20		144	4·24
10	504	19·96	18·00	17·5	4	114	4	3·83	Not ascertained.			
9½	468	18·53	16·24	15·	,,	108	3	3·67	3·40	6·34	108	3·18
9	432	17·10	14·58		3½							
8½	396	15·68	13·00		,,	78	3	2·80	2·60	6·22	84	2·27
8	324	12·83	11·52		3							
7½	288	11·57	10·00	10·25	,,	60	3	2·06	1·90	3·11	60	1·76
7	252	10·12	8·80		2½							
6½	216	8·73	7·60		,,	42	3	1·43	1·40			
6	189	7·44	6·48		2							
5½	162	6·25	5·44		,,	27	3	·92	·90			
5	135	5·17	4·50	4·27	1½	18	3	·52	·50			
4½	108	4·18	3·64		1	9	3	·23	·25			
4	90	3·31	2·88		¾	6	3	·17	·13			
3½	72	2·53	2·00									
3	54	1·86	1·64									

* This column was obtained from 95 actual trials at Woolwich, by the hydraulic press.

† This column also from 95 actual trials at Woolwich.

‡ The strength of white rope was not ascertained; but it is always greater than that of tarred rope.

R. J. N.

CAMEL—with reference to Egypt, Syria, India, and the adjacent countries.

The camel is used in the East as a beast of burthen from 3 to about 16 years of age, and in hot sandy plains, where water and food are scarce, is invaluable.

With an army, however, generally speaking, it is not so valuable as the mule or horse.

The camel under a burthen is very slow-going, about half the pace of a mule, or from 1½ to 2 miles per hour; he can, however, travel 22 out of the 24 hours, and only requires food once a day.

His load varies exceedingly in different countries. In Egypt it is as high as 10 cwt.; and for the short distance from Cairo to Boulac, even 15 cwt. is, I believe, sometimes carried.

But in Syria it rarely exceeds 500 lbs., and the heaviest load in the Engineer equipment for the Army of the Indus is stated to be 4 cwt. 48 lbs., independent of the pack-saddle. About 400 lbs. is a sufficient load on the march.

The pack-saddle or pad is secured in its place by the hump on the back, a hole being made in the pad to let it come through, also by a breast-plate and breeching; no dependence is placed on the girth, which is not kept tight.

The camel, from his great size, averaging about 7 feet to the top of the hump, and 8 feet from his nose to his tail, when standing in a natural position, is capable of carrying light field artillery, and the 12-pounder mountain howitzer, which, with its side arms, weighs from 330 to 350 lbs. The bed or carriage is carried by a second, and the ammunition by a third camel.

From his size too he carries with ease large articles, such as long poles, planks, &c., and would be admirably adapted for the conveyance of Colonel Blanshard's small pontoon bridge.—See Plate.

A camel would carry with ease two pontoons, with their saddles fixed, and several small stores.

The calculation of one camel for every pontoon would be ample for the carriage of the complete pontoon equipment.

Ten pontoons, with their superstructure complete, weigh about 26 cwt. This would therefore allow a sufficient number of spare camels.

In rocky ground the camel is apt to slip, and his fore feet then are frequently spread out right and left: when this is the case, he splits up inside the arms, and dies, or becomes useless.

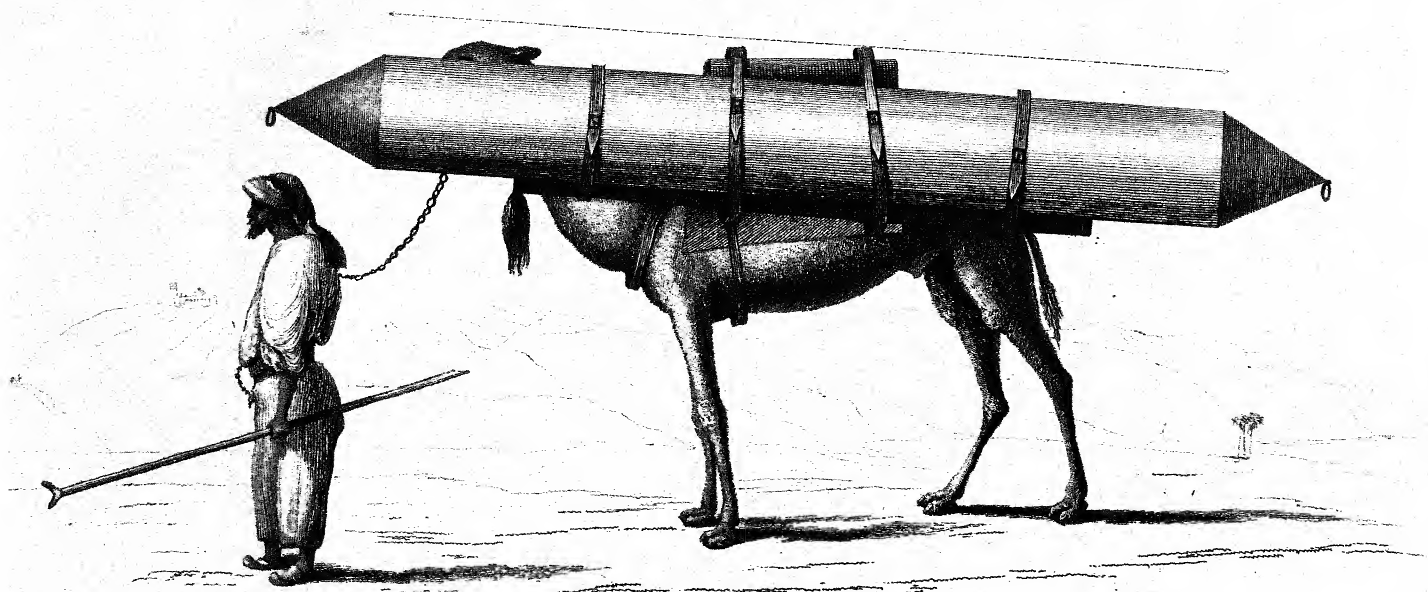
The camel, though patient and obedient to his keeper, at whose command he lies down to be loaded, is frequently very savage with strangers, and his bite is very severe.

In Syria he is less valuable than the mule, and his price is from £10 to £15.

R. Alderson,
Lieut.-Colonel and Capt. R.E.

The camel is still more liable to this 'splitting' (or rather dislocation of the shoulders) on slippery than on rocky ground; which is one reason why this animal cannot be generally used at the Cape; though usually hot and dry enough, yet, in the rains, no ground can be more slippery than the clay soils of that country.

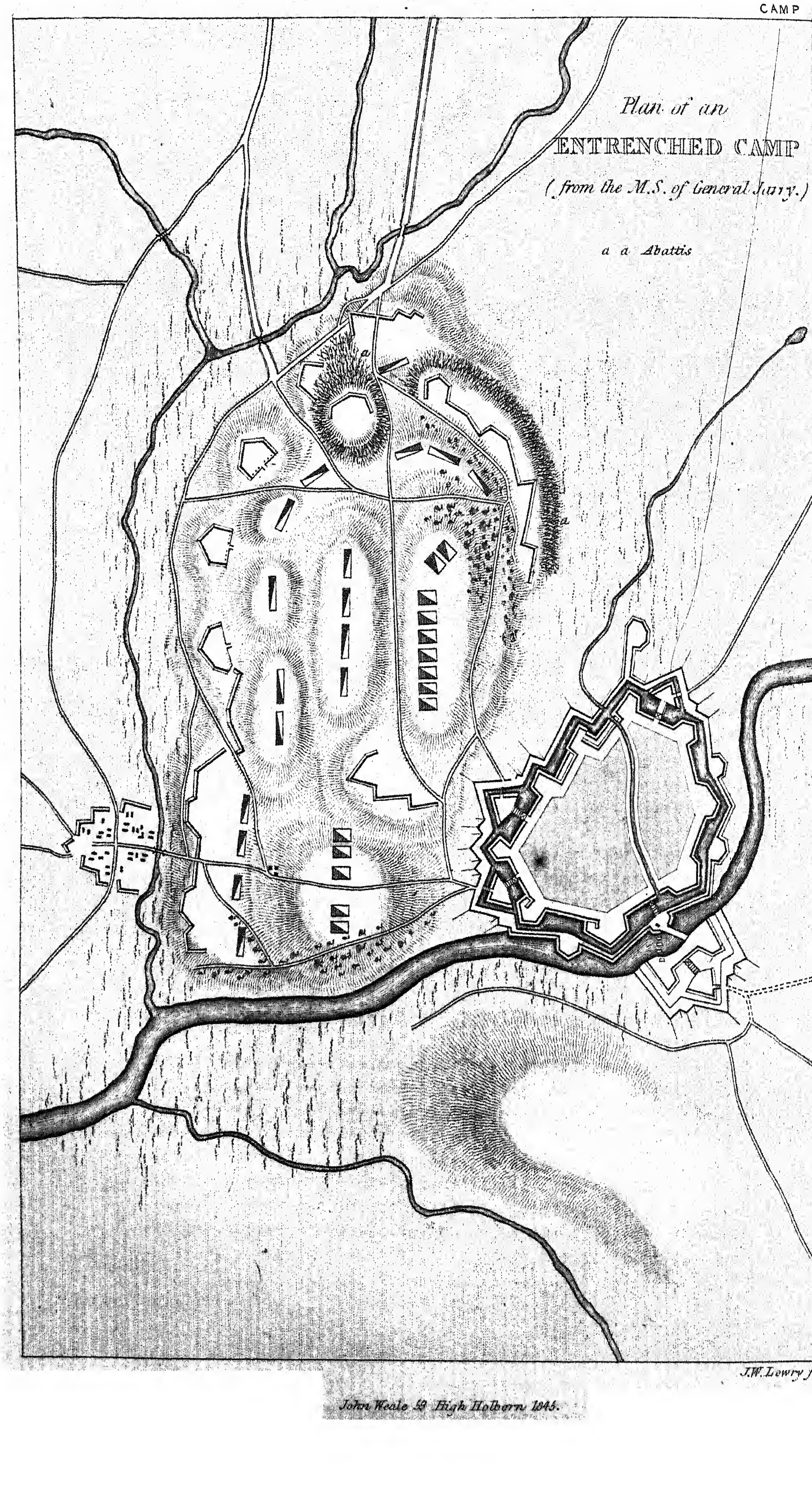
In India also the camel stands high in the list of beasts of burthen, and is so employed by all departments—Artillery, Engineer, Commissariat, and Regimental. Its long-sustained powers under the saddle are well known. It is used in some instances for mounted Corps, and for the Rocket Service. In some parts the natives mount swivels on them, called 'zumbourouks,' or wasps.



A Syrian Camel with 2 of Colonel Blanchards small Pontoons
12 ft. long each without their Ends and 2 Saddles 8 ft. 4 in. long
weighing altogather 2 cwt. 1 qr. 10 lb. without the Packsaddle.

J. H. Le Keux, sc.

London: John Weale, 1845.



J.W. Lowry fc.

John Weale 59 High Holborn 1845.

The camel is as peculiarly suited to the deserts as the mule is to the mountain,—or as the bullock to open countries without roads,—or as the horse, immeasurably and above all, to civilized countries with roads.

It is the judicious application of these useful animals that renders their services important and effective; failure results when their peculiarities are not consulted as to the country in which they are to be employed. In the late wars, however, no animal was found to have such a general suitability as the horse.

Memorandum.—The 'Camel' above mentioned is often called the Dromedary, being the one-humped variety, 'Camelus Dromedarius,' of Buffon and Cuvier. The two-humped, or 'C. Bactrianus,' is a larger and more powerful beast, better adapted to carry burthens, and to wet soils, but, like the Dromedary, quickly ruined by those of a stony character. On the deserts, the latter, under the saddle, will go from 10 to 12 miles per hour, without water, food, or intermission, for many hours together.

R. J. N.

CAMP, INTRENCHED.—The application of Intrenched Camps, as a strategic question, is sufficiently explained in the 'Sketch of the Science and Art of War,' at the commencement of this volume.

An Intrenched Camp does not necessarily imply fortifying ground on which the troops are under canvas; but the general term comprehends fortifying a space or enclosure, whether the troops are encamped, bivouacked, or hutted: for the Distribution of the Troops, see 'Castrametation.'

As regards the works for intrenched camps, they are similar to those placed in fortifying a position, and taking advantage of natural obstacles, and resources found on the spot; but the intrenched camp is generally taken up for temporary purposes, whilst the fortified position is of a permanent nature, at least during hostilities.

Intrenched Camps are seldom constructed, in consequence of the immense labour; and when required, their use appears to be limited to the following objects:

1. For the security of an army or corps to cover a siege.
2. To intrench a corps of observation for the security of a line of frontier or territory, whilst the main army is occupied with offensive operations in another direction.
3. For the defence of a frontier; placed in conjunction, or immediate connection, with a fortified place.

Vauban attached great importance to this last proposition of constructing intrenched camps; and he considered that one or two positions thus taken up by a force in an unattackable site, except by a regular siege, would enable an inferior army between them to contend against an enemy greatly superior.—See Plate of an Intrenched Camp.

The following rules are generally adopted in the selection of ground for an Intrenched Camp.

1. The site supposes an advantageous ground to which it is only necessary to add some artificial assistance. The fortifications are disposed as if they were the enceinte of a place, of which the bastions, or works, are detached and closed by the gorge, to form so many separate forts. Curtains, if used, may be added, but not joined to the bastions, in order to leave sufficient passages for the troops. One of the principal considerations in the choice of a site is having sufficient depth for the formation of the troops; and the ground should not be open to a cannonade from the neighbouring heights;—and all villages within 1500 yards should be occupied, and all obstructions within that distance removed.

2. An inaccessible position is not always taken up, without it can be easily succoured, if necessary; as an intrenched camp seldom has all the resources for a long defence, and the means of retreat should be considered.

3. The junction of two rivers frequently offers an advantageous site for an intrenched camp; particularly in connection with a fortified place, as such a position is difficult to blockade, and easily succoured.

4. An ample supply of stores, ammunition, food, fuel, forage, and water, is necessary to meet the object of occupying the fortified camp; for without these, the expense and labour are thrown away.

The detail of construction will be found under the head of 'Field Fortification,' and their application is further exemplified in the 'Defence of Posts, Villages, and Open Towns;' for an Intrenched Camp is a judicious combination of these resources, taking advantage, as before observed, of natural obstacles, such as inundation, marshes, bog, or precipitous ground. G. G. L.

CAPONIÈRE.—This description of defence, when intended to be occupied, is only suited to permanent Field Fortification, on account of the great relief necessary to cover it, and the labour and expense attendant, if on a footing likely to be efficient.

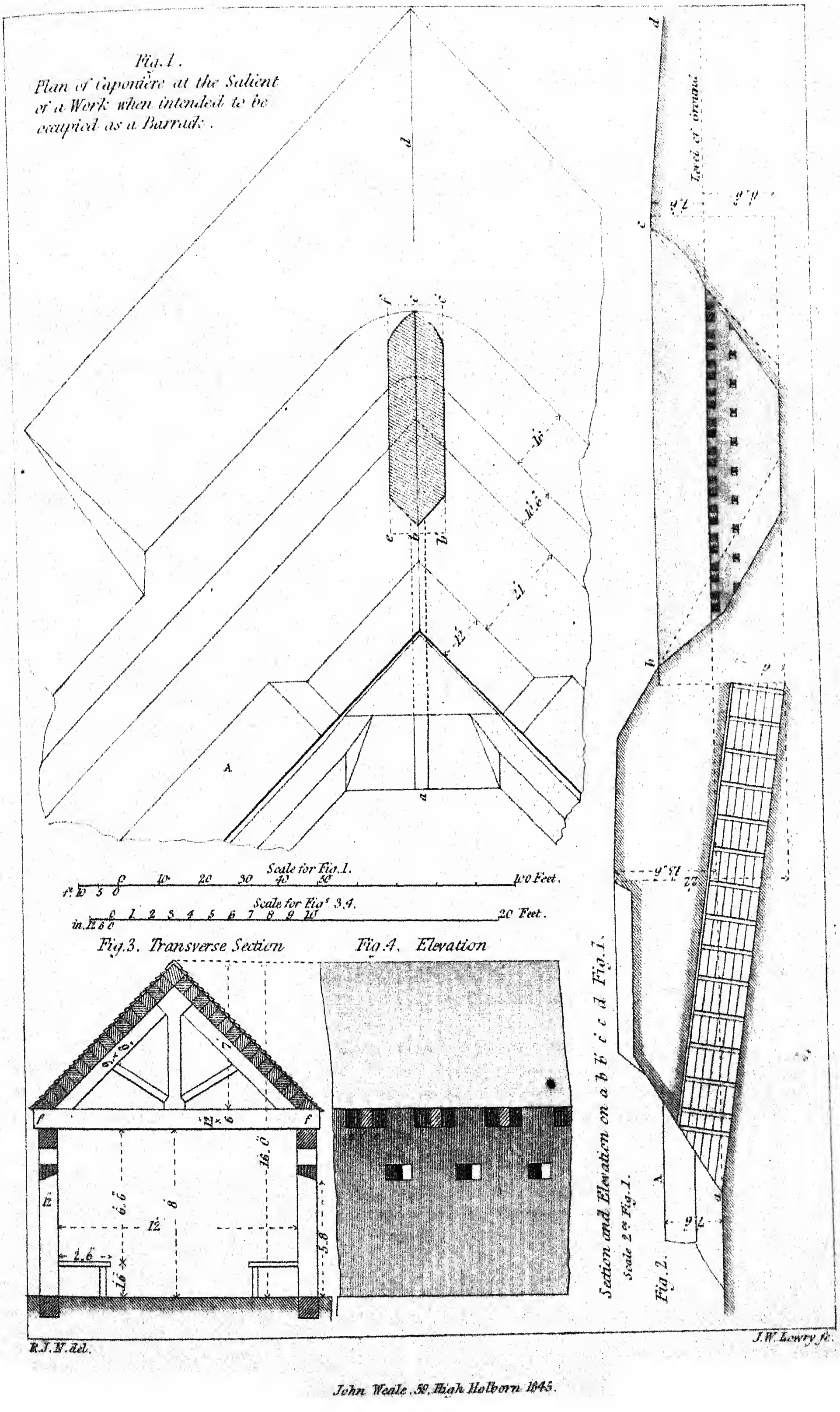
Fig. 3, Plate I., shews the lowest section that can be given in this case; and even then the principle of having the loopholes 8 feet, at least, above the ground, has been sacrificed to reduce the height of the rampart as much as possible. It is not, however, requisite that the whole work should have the dimensions of figs. 1, 2, near the salient: taking advantage of the extra height to establish a cavalier, the parapet may soon drop to an ordinary section, as at A: much of the earth from the ditch in the neighbourhood of that point will be required for the completion of the salient and its glacis.

Such a caponière becomes a complete wooden house (shewn in plan by *e*, *f*, *b′*, *c′*, fig. 1, Plate I.), built on the level of the bottom of the ditch, being let into the escarp at one end, but separated from the counterscarp, and communicating with the work by a gallery.

With reference to fig. 3, Plate I., it is presumed to be proof against musketry and splinters of howitzer shells, though not against the shells themselves, any more than the sides of a ship are proof against shot. The loopholes are only 5 feet 8 inches above the ground, instead of 8 feet, as above explained, but they may be protected by abattis to such extent as will not mask their fire—ditches in front being objectionable as accumulating stagnant water.* Sufficient width is given to admit of two opposite ranks loading and handing the muskets to the men on the banquettes. Spaces, *e*, *e*, fig. 4, are left on each side of the tie-beams for ventilation; they and the loopholes can be fitted with small sliding sashes.

Eighteen or twenty men can sleep on the banquettes, lengthwise; in extreme cases, treble that number will find shelter, if placed also on camp trestles and boards on the ground, to be packed up and put away under the banquette when not wanted as beds or tables. Every precaution must be taken to preserve these caponières dry, if to be thus inhabited: the ends of the building should be kept from touching the earth by means of dry rubble; the bottom of the ditch sloped so as to carry off rain or spring

* Except in case of a gravelly soil, through which water will pass freely; in clay or loam it will stagnate; sand ditches will not preserve their dimensions; and sinking in rock for a field-work can hardly be required.

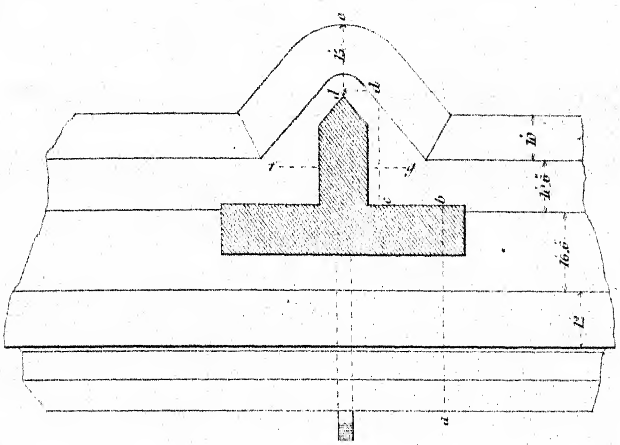


R. J. N. del. J. W. Lowry sc.

John Weale, 59, High Holborn 1845.

Fig. 1.

Plan of a Caponière on the Face of a Work when not intended to be occupied as a Barrack.



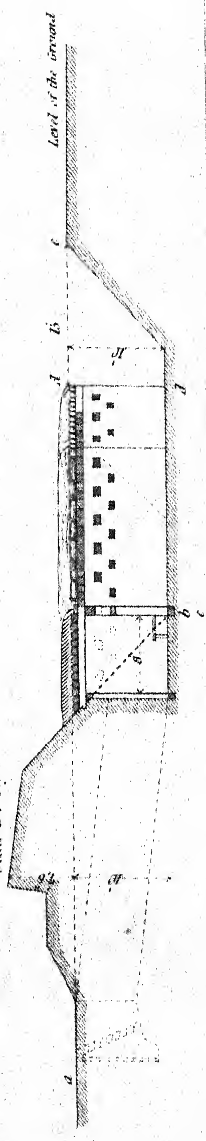


Fig. 2. Section & Elevation on a b, c d, d e, Fig. 1.
Scale 2ce Fig. 1

Fig. 3.
Transverse Section on f g.

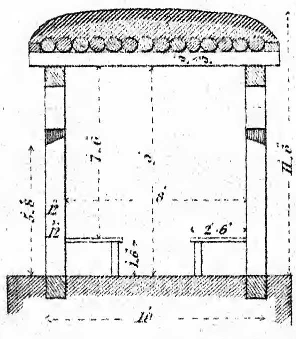
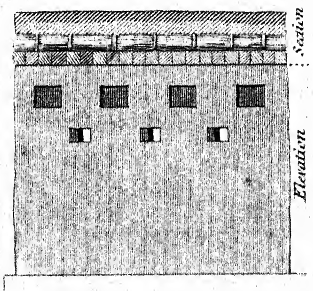
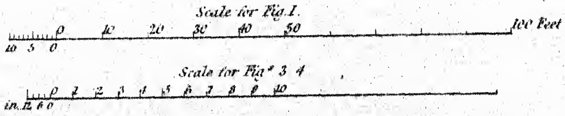


Fig. 4.
Elevation on c d.





R.J.N. del. J.W. Lowry fc.

John Weale, 59, High Holborn, 1845.

water; the walls well caulked with moss, oakum, flax or hemp combings, or the inside bark of most trees,—this caulking followed up as the wood-work shrinks; and the floor of well-rammed clay, finished on the top with dry gravel; and the whole may be weather-boarded outside.

In fig. 3, Plate I., the walls are given as of solid upright baulks, between a capsill and groundsill; they may, however, be laid horizontally, as shewn in 'Blockhouse,' Plates I. II.; or, if no baulk can be obtained, the thickness of 12 inches may be made good by courses of plank crossing each other, which give stability, and a more comfortable dwelling, as being less liable to the annoyances occasioned by the shrinking of the timber.

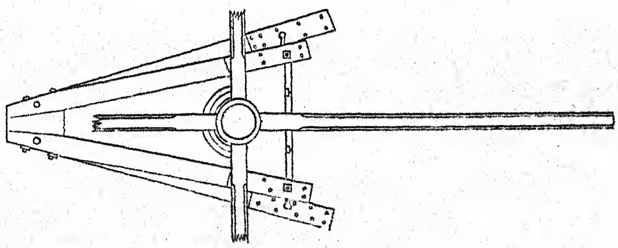
If to avoid the objection of raising the work to such a height, the caponière be sunk so that the loopholes are nearly flush with the ground, there will still be 11 feet left above that level: it cannot be used conveniently as a barrack; and the defenders will be liable to being taken in reverse through the openings left for ventilation.

When *not* intended to be occupied, such a section as fig. 3, Plate II., will be advisable: the roof is sufficiently weather and splinter-proof; and a less width in the interior is necessary. It is not recommended to sink a caponière on any account; ditches being objectionable, the defenders are, as above, liable to be fired on through the ventilators, and, being thus cooped up, and annoyed with smoke, are worse off than the assailants: without ventilation, these works are untenable. A less width or height than 8 feet is very objectionable.

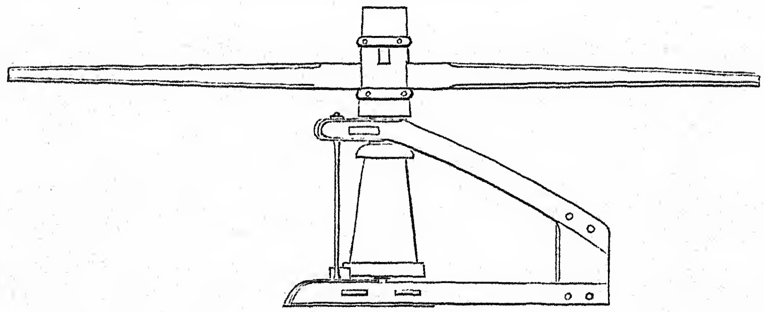
In Plate I. fig. 1, the caponière having abutments at both ends, the structure will be necessarily stable; but in Plate II. fig. 1, the outer end has not this advantage. The inside of the walls and the roof, therefore, must be well braced with diagonal battens. It is also to be observed that no extra height of parapet or rampart is absolutely necessary in Plate II. The ditch is made wider there than may be requisite in other parts of the work, so as to give a respectable flanking defence; and if command is necessary for the parapet, the ditch may be shallower, but then the requisite cover for the caponière must be given by a small glacis, as in fig. 1, Plate I.

A caponière may be used as a bridge: the section in fig. 3, Plate II., is quite adapted to this purpose. R. J. N.

CAPSTAN, FIELD.—The following wood-cut gives a simple and very effective capstan, which is easily made. As there is no wheel-work or other provision for multiplying power, this last is to be supplied by main force, presumed to be generally and abundantly available when such contrivances are required. In connection with blocks and tackles, it is applicable to straining the tension gear of rope bridges, as well as to many other engineer purposes, and can be used with sheers in embarking and disembarking artillery, &c.



It is sometimes, but improperly, called the Crab Capstan.



CARCASS.—*See* 'PYROTECHNY.'

CARRIAGES.*—(LAND AND SEA SERVICE.)

I. LAND SERVICE.

The carriages employed in the British Land Service are, 1st, Those which accompany an army into the field and through a campaign; and, 2nd, Those employed in the defence of garrisons, fortresses, and coast defences.

Of the former there are two classes, viz. those employed for field and mountain service, and those for sieges.

Field and mountain service.

The carriages for field service consist of the gun-carriages for medium 12, 9, light 6 and 3-pr. guns; 32, 24, and 12-pr. howitzers, with their limbers and ammunition waggons; also forge, store, and Flanders waggons; rocket waggons, carriages for the conveyance of stores, infantry and cavalry ammunition, bridge equipage, intrenching tools, and hospital equipment.

The light 3-pr. gun and 4⅖ howitzer are employed for mountain service.

For detail of their equipment, see article 'Mountain Service.'

The height of wheel is the same throughout the field service, viz. 5 feet; the fore-wheels of the Flanders and pontoon waggons excepted, which are 4′ 2″, and the wheels of the hospital waggon, which are 3′ 6″. The track from out to out is the same for all, viz. 5′ 3″.

The limber is the same throughout the Service for gun, howitzer, gun ammunition waggon, ball-cartridge, forge, and store waggons; but the ammunition boxes vary in depth according to the nature of ordnance they belong to. They are all of the same dimensions externally in the floor, and will fit any limber or waggon body.

All shafts are transferable from one carriage to another, and can be adapted to single, double, or treble draught, as may be required. The pole also may be used when necessary to resort to bullock draught.

Ammunition waggons are fitted to carry a spare wheel on the perch of the waggon

* By Captain Clerk, Royal Artillery.

body, also spare shafts, splinter-bars, perches, &c. Every gun carriage carries a provision of spare horse-shoes and nails, of which a proportion are fitted to the horses that belong to it. The store limber waggon carries in the limber all the tools necessary for the wheelers and collar-makers, together with material for the repair of harness; and the forge waggon in a similar manner carries all the tools necessary for the smiths and farriers' use, together with horse medicines, iron-work (fitted and in the rough), and a portion of coals.

Field Batteries of Position.

In addition to the carriages already mentioned, there are for the heavy batteries of position,—the 18-pr. gun and 8-inch howitzer carriages, with their limbers and ammunition waggons,—forge, platform, and store waggons. These carriages are fitted either for shafts or pole, according as it may be necessary to use horse or bullock draught. The gun and howitzer carriages are of the same construction as those for the battering train.

For all field guns there is provided a due proportion of spare gun carriages, which march with the Reserve.

Siege Carriages.

The second class of carriages which accompany an army are those employed in Sieges. They consist of the gun carriage for 24, 18, and heavy 12-pr. guns, the 10 and 8 inch howitzers, with their limbers and ammunition waggons; also platform waggons for the conveyance of heavy guns in convoy, and for the transport of 10 and 8 inch mortars and their beds,—carriages for the conveyance of ammunition, stores, material for the construction of batteries and the service of the trenches.

The same height of wheel is given to the gun and howitzer carriage as in the field service, viz. 5 feet, but the limber wheels are 3 feet 10 inches in diameter.

The $5\frac{1}{2}$ and $4\frac{2}{5}$ brass mortars may be conveyed in store limber or Flanders waggons. One waggon can convey from four to six $5\frac{1}{2}$-inch, or eight $4\frac{2}{5}$-inch mortars, including their beds, side arms, and stores.

All carriages belonging to the siege equipment are fitted for either horse or bullock draught.

In order to distribute the weight more equally when travelling, the carriages for heavy guns are fitted with two sets of trunnion boxes, called the 'fighting' and 'travelling' 'trunnion boxes.' The field 12-pr. medium and 32-pr. howitzer are also fitted in this manner.

Garrison Carriages.

To this class belong the gun carriages for heavy ordnance employed in the defence of fortresses and coast defences, including traversing platforms and carriages for the local transport of ordnance, ammunition, and stores, viz. sling cart, sling waggon, devil carriage, &c.

The garrison gun carriage consists of two brackets connected by transoms and bolts to axle-trees, and supported on iron trucks. The carriages are raised to such a height as to enable them to fire over a 2′ 3″ genouillère with a depression of 5°. The length of axle-tree is the same for all, in order that they may be mounted on the traversing platform.

The other dimensions vary with the nature of ordnance.

Depression carriages are somewhat longer than common garrison gun carriages, and admit of a depression of 30°. See page 219.

The dwarf traversing platform and sliding gun carriage are a modification of the naval slide and carriage, and are employed both in fortresses and coast defences. They are suited to the Infantry parapet of 51 inches above the banquette; and, when required to fire, en barbette, over a parapet of greater height, the supports of the racers are raised in proportion. For casemates a platform is used similar to the dwarf, but suited to a low genouillère without front trucks. The radii of racers and extreme front projection are the same for both natures of platform (viz. 56-pr. and

32-pr.), the only difference being in scantling and breadth. The pivot-eye is also universal.

The following Table shews the different modes of pivoting, the radii of racers, and distances from centre of pivot to extreme corners of the platform; the length of the platform being always 16 feet, with a slope of 5° to the rear.

Nature of Pivot.	Radii of Racers. Front.	Radii of Racers. Rear.	Distance from ⊖ of Pivot: To extreme front projection.	Distance from ⊖ of Pivot: To Rear corner. 56-prs.	Distance from ⊖ of Pivot: To Rear corner. 32-prs.
	′ ″	′ ″	′ ″	′ ″	′ ″
Front pivot . . .	1 10	12 10	2 1·8	16 3½	16 3
Centre ditto . . .	6 1	6 1	6 9·9	9 5½	9 4¾
Intermediate . .	9 0	3 4¼	9 9·4	6 7	6 5¾
Rear before chock .	10 8¼	2 2	11 5·7	5 0	4 10¼
Rear behind chock .	12 10	2 2	13 7·6	3 2	2 11

II. SEA SERVICE.

The carriages employed in Her Majesty's Navy are, for the gun and upper decks, pivot-slides and carriages for traversing guns, and for Boat and Field Service.

Carriages for Ship-board.

The common truck carriage, similar to the garrison gun carriage, but with trucks of wood instead of iron, is generally used for the gun-decks, and for the heavier guns of the upper decks. These carriages vary in height according to the port-sills of the decks they belong to, and are so arranged as to allow of a depression of about 7°, and an elevation of about 9°. The following Table gives the height of port-sill of the different decks belonging to each class of H. M. Navy. All Steamers have a uniform height of 1 foot 6 inches for lower port-sill of the spar-decks.

Number of guns.	Name of Class.	Height of Port-sill from Deck. Quarter Deck. Lower sill.	Quarter Deck. Upper sill.	Main or Upper. Lower sill.	Main or Upper. Upper sill.	Middle. Lower sill.	Middle. Upper sill.	Lower. Lower sill.	Lower. Upper sill.
		′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
110	Queen . . .	1 8	4 4	1 11	4 7	1 11	4 10	2 3	5 2
90	Albion . . .	1 8	4 4	1 11	4 10	,,	,,	2 3	5 2
80 70	Vanguard . Cumberland	1 8	4 4	1 11	4 10	,,	,,	2 3	5 2
50	Vernon . . .	1 10	4 8	1 11	4 10	,,	,,	,,	,,
36	Pique . . .	1 8	4 4	1 11	4 10	,,	,,	,,	,,
36	Castor . . .	1 8	4 4	1 11	4 10	,,	,,	,,	,,
26	Carysfort . .	,,	,,	1 11	4 7	,,	,,	,,	,,
	Brigs . . .	,,	,,	0 8	4 1	,,	,,	,,	,,

The 32-pr. guns of 25 and 32 cwt. and carronades are usually mounted on 'Hardy's compressor carriage.'

The 68-pr. 10 inch, and sometimes the 8 inch and 32-pr. guns, are mounted on pivot-slides and sliding carriages. These are of the same width as the dwarf traversing platform and sliding carriage of the Land Service, so that the gun carriage of one Service may be used, in a case of necessity, for that of the other. The naval slide may also be used on shore.

Carriages for Boat Service.

The carriages for Boat Service are for the 24-pr., light and heavy 12-pr. howitzers, the light 6-pr., and occasionally the light 3-pr. gun.

The carriage consists of two parts, called 'boat and under' carriage: when in boats, the former only is necessary. The under carriage has two trucks in front, with dead-block in rear, and to it the boat carriage is secured, when on ship-board, by two screws, constituting one small gun-carriage, which is adapted for firing into tops. The following are the angles to which they elevate:

24 and heavy 12-pr. howitzer, to	28°
Light 12-pr. howitzer, to	43½
Light 6-pr. gun, to	42

Carriages for Field Service.

The field carriages for the Navy are for the 24 and light 12-pr. howitzers: they are similar in construction to those of the Land Service, but of reduced dimensions, with wheels of less diameter and weight. They receive the boat guns when disembarked.

The limber is the same for each, and the ammunition boxes are placed in the direction of the wheels instead of at right angles to them, so as to be more readily got at. They are fitted either for pole, shaft, or to be worked by hand when necessary. The ammunition boxes of the light 12-pr. howitzer are fitted to the limber in such a manner as to be easily detached and carried by men or on a pack-saddle, and the limber may, when the boxes are thus carried, be conveniently used as a hand-cart.

The following Table gives the weights and dimensions of wheels of the naval field carriages, also the number of rounds carried in the limber.

Weight of the		24-pr.			Light 12-pr.			
		cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	oz.
Howitzer Carriage.	Body . . .	7	0	12	4	1	6	12
	Wheels . .	2	3	20	1	3	26	0
Ditto Limber.	Body . . .	2	0	4	1	3	16	4
	Wheels . .	2	3	20	1	3	26	0
	Ammunition	4	2	16	3	2	19	13
Total weight . .		19	2	16	13	3	10	13
Number of rounds carried		20			24			
Diameter of wheels . .		4′ 2″			3′ 6″			
Track from out to out .		4 2			3 8			

A light 6-pr. gun carriage of the same pattern as the light 12-pr. howitzer has also been constructed; the weight of the carriage and wheels being 5 cwt. 2 qrs. 1 lb.

Mortars.

The 13 and 10 inch sea-service mortars are mounted on wooden or iron beds, in vessels provided for the purpose.

Material employed.

The woods most generally used in the construction of land and sea-service carriages are,—oak, elm, and ash, of British growth; also, teak, mahogany, sabicer, fir, African oak, and some other tropical woods, for service in these climates.

All land-service travelling gun carriages are usually made of oak: iron garrison gun carriages are sometimes used in situations not exposed, within a certain distance, to the enemy's fire, and where wooden carriages would suffer from exposure to the sun and weather: but, of late years, teak and other tropical woods have been introduced in place of iron or oak, more particularly in hot climates.

Shafts, perches, splinter-bars, and felloes of wheels, are of ash; the nave of the wheel is elm, and the spokes oak.

Sea-service carriages are made of elm, with an axle-tree of oak, except the carriages for the upper decks, which are sometimes of mahogany and other tropical woods.

The following Tables and Plates represent the principal Carriages employed in the Land Service.

TABLE I.—24-POUNDER SIEGE GUN.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	* Gross weight.	Total length on line of march.
	cwt. qrs. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Gun carriage . .	23 3 25¾	239	23 9	6 7¼	9 7¾	4 10½	4 6½	5	5 0	179	61
,, limber . . .	7 1 27½			6 2½		4 10½	4 6	3¼	3 10		
Pair of wheels, fore	3 2 10	40	,,	,,	,,	,,	,,	3¼	3 10	,,	,,
,, hind	8 1 12	90	,,	,,	,,	,,	,,	5	5 0	,,	,,
Axles, fore . . .	1 0 6	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
,, hind . . .	1 3 2½	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

* *Note to Tables.*—The two last columns in Tables I. to XII. have been computed partly from the known data in the other columns, and partly from the known weight of guns, &c., and the probable number of horses and men accompanying each carriage as it passes over a bridge: it is to shew the strain thus brought on bridges that these columns have been added; only it should be borne in mind that all calculations in such cases refer to *moving* and not to *dead* weights.

The 'Length on the Line of March' includes the length of one horse as the regulation distance between two successive carriages.

The length given in the fourth column is that of each carriage when limbered up, but without horses.

TABLE II.—18-pounder Iron Gun.

	Weight.			Bulk as for tonnage.	Total length as placed in a gun shed.		Length of axle or extreme breadth of carriage.		Distance between fore and hind axles.		Breadth between wheels at the tires. Above.		Breadth between wheels at the tires. Below.		Breadth of tire.	Diameter of wheel.		Gross weight.	Total length on line of march.
	cwt.	qrs.	lbs.	cub. ft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	in.	ft.	in.	cwt.	ft.
Gun carriage . .	18	1	26¾	199	21	6	6	4¾	8	2½	4	11	4	6	4	5	0	162	59
„ limber . . .	7	1	27½				6	2½			4	10½	4	6	3¼	3	10		
Ammunition waggon	10	3	24	240	„		6	3	7	7¾	5	5	4	9	2½	5	0	115	48
„ limber	8	2	10¼				6	3			5	5	4	9	2½	5	0		
Pair of wheels, fore	3	2	10	40	„		„		„		„		„		„	3	10	„	„
„ hind	7	0	0	65	„		„		„		„		„		„	5	0	„	„
Axles, fore . . .	1	0	6	„	„		„		„		„		„		„	„		„	„
„ hind . . .	1	1	18	„	„		„		„		„		„		„	„		„	„

TABLE III.—12-pounder Medium Gun.

	Weight.			Bulk as for tonnage.	Total length as placed in a gun shed.		Length of axle or extreme breadth of carriage.		Distance between fore and hind axles.		Breadth between wheels at the tires. Above.		Breadth between wheels at the tires. Below.		Breadth of tire.	Diameter of wheel.		Total weight.	Total length on line of march.
	cwt.	qrs.	lbs.	cub. ft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	in.	ft.	in.	cwt.	ft.
Gun carriage . .	12	2	8	234	23	9	6	5	9	9½	5	5½	4	9	2¾	5	0	140	61
„ limber . . .	9	2	2				6	5			5	5½	4	9	2¾				
Ammunition waggon	10	3	9	240	20	4	6	3	7	7¾	5	5	4	9	2½	5	0	114	48
„ limber	8	2	7																
Store limber carriage	10	3	7	227	20	7	6	3	7	8	5	5	4	9	2½	5	0	74	48
„ limber	8	0	10																
Forge waggon . .	9	2	26	239	20	8	6	3	7	1½	5	5	4	9	2½	5	0	74	48
„ limber	8	0	10																
Baggage cart . .	9	0	8	104	12	8	6	3	„		5	5	4	9	2½	5	0	48	23
Pair of wheels, light	3	2	20	43	„		„		„		„		„		2½	5	0	„	„
„ heavy	4	1	8	47	„		„		„		„		„		2¾	5	0	„	„
Axle	1	0	2	„	„		„		„		„		„		„	„		„	„

TABLE IV.—9-POUNDER GUN.

	Weight.			Bulk as for tonnage.	Total length as placed in a gun shed.		Length of axle or extreme breadth of carriage.		Distance between fore and hind axles.		Breadth between wheels at the tires. Above.		Below.		Breadth of tire.	Diameter of wheel.		Total weight.	Total length on line of march.
	cwt.	qrs.	lbs.	cub. ft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	in.	ft.	in.	cwt.	ft.
Gun carriage	12	0	19	201	22	7¼	6	5	9	2	5	5½	4	9	2¾	5	0	134	61
„ limber	8	1	24				6	3			5	5	4	9	2½	5	0		
Ammunition waggon	10	3	11	238	20	4	6	3	7	7¾	5	5	4	9	2½	5	0	113	48
„ limber	8	1	24																
Store limber carriage	10	3	7	227	20	7	6	3	7	8	5	5	4	9	2½	5	0	74	48
„ limber	8	0	10																
Forge waggon	9	2	26	239	20	8	6	3	7	1½	5	5	4	9	2½	5	0	74	48
„ limber	8	0	10																
Baggage cart	9	0	8	104	12	8	6	3	„		5	5	4	9	2½	5	0	48	23
Pair of wheels, light	3	2	20	43	„		„		„		„		„		2½	5	0	„	„
„ heavy	4	1	8	47	„		„		„		„		„		2¾	5	0	„	„
Axle, light	0	3	12	„	„		„		„		„		„		„	„		„	„
„ heavy	1	0	2	„	„		„		„		„		„		„	„		„	„

TABLE V.—LIGHT 6-POUNDER GUN.

	Weight.			Bulk as for tonnage.	Total length as placed in a gun shed.		Length of axle or extreme breadth of carriage.		Distance between fore and hind axles.		Breadth between wheels at the tires. Above.		Below.		Breadth of tire.	Diameter of wheel.		Total weight.	Total length on line of march.
	cwt.	qrs.	lbs.	cub. ft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	in.	ft.	in.	cwt.	ft.
Gun carriage	9	1	15	182	21	10	6	3	8	9½	5	5	4	9	2½	5	0	104	59
„ limber	8	1	18																
Ammunition waggon	10	3	4	235	20	3½	6	3	7	7¾	5	5	4	9	2½	5	0	112	48
„ limber	8	1	18																
Store limber carriage	10	3	7	227	20	7	6	3	7	8	5	5	4	9	2½	5	0	74	48
„ limber	8	0	10																
Forge waggon	9	2	26	239	20	8	6	3	7	1½	5	5	4	9	2½	5	0	74	48
„ limber	8	0	10																
Baggage cart	9	0	8	104	12	8	6	3	„		5	5	4	9	2½	5	0	48	23
Pair of wheels	3	2	20	43	„		„		„		„		„		2½	5	0	„	„
Axle	0	3	12	„	„		„		„		„		„		„	„		„	„

TABLE VI.—Light 3-pounder Gun.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qrs. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Gun carriage . .	4 1 9	90	16 6	4 8	6 7¼	3 11	3 7½	2¼	4 4	97	44
„ limber . . .	3 3 4										
Limber car . . .	3 3 16	51	9 4	4 8	„	3 11	3 7½	2¼	4 4	62	28
Pair of wheels . .	2 1 0	28	„	„	„	„	„	2¼	4 4	„	„
Axle	0 1 10	„	„	„	„	„	„	„	„	„	„

TABLE VII.—3-pounder Mountain Gun.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qrs. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Gun carriage . .	1 3 17	23	12 1	3 1½	„	2 3¼	2 3¼	1¾	3 0	24	22
Shafts	0 1 17										
Boxes, large . .	1 0 8	18	„	„	„	„	„	„	„	„	„
„ small . . .	0 2 11										
Pair of wheels . .	0 3 22	11	„	„	„	„	„	1¾	3 0	„	„
Axle	0 0 20½	„	„	„	„	„	„	„	„	„	„

TABLE VIII.—10-inch Iron Howitzer.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qrs. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Howitzer carriage .	31 2 10	258	23 0	6 7½	9 9½	4 10½	4 6½	5	5 0	180	60
„ limber .	7 2 0			6 2½		4 10½	4 6	3¼	3 10		
Pair of wheels, fore	3 2 10	29	„	„	„	„	„	3¼	3 10	„	„
„ hind	8 1 12	63	„	„	„	„	„	5	5 0	„	„
Axle, fore . . .	1 0 6	„	„	„	„	„	„	„	„	„	„
„ hind . . .	1 3 3	„	„	„	„	„	„	„	„	„	„

TABLE IX.—8-inch Iron Howitzer.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qrs. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Howitzer carriage .	24 1 14	238	21 5	6 4¾	9 0	4 11	4 6	4	5 0	154	59
„ limber .	7 2 0			6 2½		4 10½	4 6	3¼	3 10		
Ammunition waggon	11 0 0	239	20 4	6 3	7 7¾	5 5	4 9	2½	5 0	116	48
„ limber .	8 2 20										
Pair of wheels, fore .	3 2 10	29	„	„	„	„	„	3¼	3 10	„	„
„ hind	7 0 0	55	„	„	„	„	„	4	5 0	„	„
Axle, fore	1 0 6	„	„	„	„	„	„	„	„	„	„
„ hind . . .	1 1 18	„	„	„	„	„	„	„	„	„	„

TABLE X.—32-pounder Brass Howitzer.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qrs. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Howitzer carriage .	12 2 19	230	23 0	6 5	9 9½	5 5½	4 9	2¾	5 0	140	60
„ limber .	9 3 0										
Ammunition waggon	10 3 1	240	20 4	6 3	7 7¾	5 5	4 9	2½	5 0	115	48
„ limber .	8 2 11										
Pair of wheels . .	4 1 8	47	„	„	„	„	„	2¾	5 0	„	„
Axle	1 0 2	„	„	„	„	„	„	„	„	„	„

TABLE XI.—24-pounder Brass Howitzer.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qrs. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Howitzer carriage .	12 2 13	207	21 8	6 5	8 10½	5 5½	4 9	2¾	5 0	134	59
„ limber .	8 2 5			6 3		5 5	4 9	2½	5 0		
Ammunition waggon	10 3 5	238	20 4	6 3	7 7¾	5 5	4 9	2½	5 0	114	48
„ limber .	8 2 5										
Pair of wheels, light	3 2 20	43	„	„	„	„	„	2½	5 0	„	„
„ heavy	4 1 8	47	„	„	„	„	„	2¾	5 0	„	„
Axle, light . . .	0 3 12	„	„	„	„	„	„	„	„	„	„
„ heavy . . .	1 0 2	„	„	„	„	„	„	„	„	„	„

TABLE XII.—12-pounder Brass Howitzer.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axle.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qrs. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Howitzer carriage .	9 3 14	182	21 2	6 3	8 10¾	5 5	4 9	2½	5 0	125	58
„ limber .	8 0 21										
Ammunition waggon	8 3 22	237	20 4	6 3	7 7¾	5 5	4 9	2½	5 0	112	48
„ limber.	8 1 3										
Pair of wheels, light.	3 2 20	43	„	„	„	„	„	2½	5 0	„	„
„ heavy	4 1 8	47	„	„	„	„	„	2¾	5 0	„	„
Axle	0 3 12	„	„	„	„	„	„	„	„	„	„

TABLE XIII.—4⅗-inch Mountain Howitzer.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qrs. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Beds with bearing poles * . . .	1 0 5										
Ammunition boxes, 2 large	0 2 18	20	„	„	„	„	„	„	„	„	„
„ 4 small	1 0 23										

TABLE XIV.

	Garrison Carriages. Iron. Weight. cwt. qrs. lbs.	Garrison Carriages. Iron. Value. £. s. d.	Garrison Carriages. Wood. Weight. cwt. qrs. lbs.	Garrison Carriages. Wood. Value. £. s. d.	Traversing Platforms. Iron. Weight. cwt. qrs. lbs.	Traversing Platforms. Iron. Value. £. s. d.	Traversing Platforms. Wood. Weight. cwt. qrs. lbs.	Traversing Platforms. Wood. Value. £. s. d.
32-pr. gun	23 0 22	10 17 7	13 0 2	16 0 11			25 1 2	27 11 0
24-pr. „	21 2 18	10 0 6	12 2 16	14 13 6	51 0 0	27 13 4	22 0 27	25 7 9
18-pr. „	18 1 6	9 1 6	10 2 2	12 16 2			22 0 27	25 7 9
12-pr. „	16 2 20	8 1 9	9 3 8	11 13 6	„	„	„	„
9-pr. „	14 3 22½	7 7 6	9 0 25	11 1 9	„	„	„	„
6-pr. „	14 2 10	6 17 6	7 2 24	9 6 6	„	„	„	„

	Weight. cwt. qrs. lbs.	Value. £. s. d.
Dwarf Traversing Platform		28 9 5
Carriage for a 32-pr. of 56 cwt. to correspond.		23 1 11
		51 11 4†
Carriages for 24-pounder iron howitzer — iron carriage	15 2 10	8 15 3
Carriages for 24-pounder iron howitzer — wood carriage		10 4 5

* As prepared for Syria in 1840; and for Hong Kong in 1844. These beds are something like garrison carriages without trucks. One mule carries two of them, or one howitzer.

† Average of a number, £50.

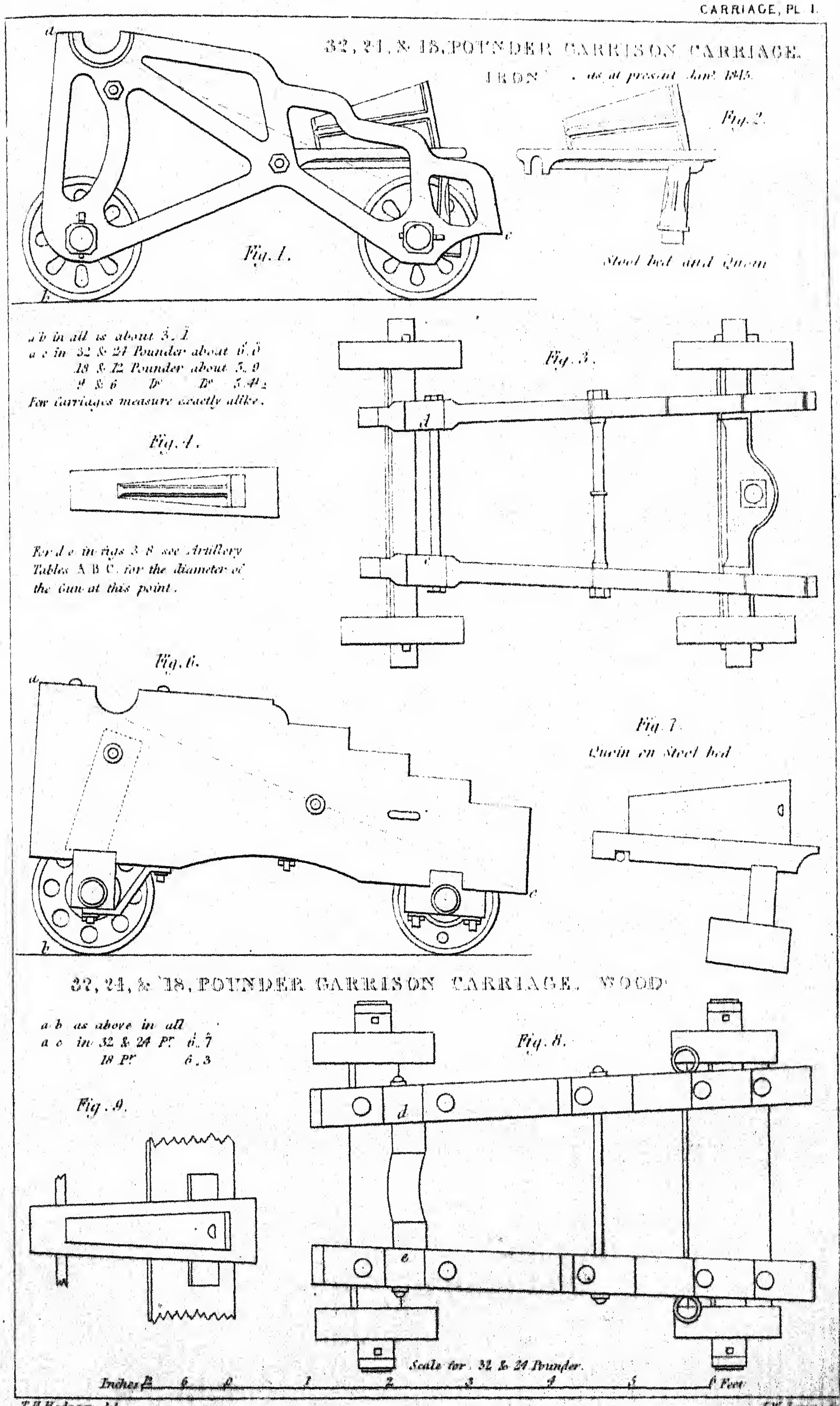
TABLE XV.*

Garrison Carriages, &c.		Wood, (Block trail.) cwt.	qrs.	lbs.	Iron. cwt.	qrs.	lbs.
68-pr. carronade		17	2	25	,,		
42-pr. ,,		10	1	21	,,		
32-pr. ,,		8	3	24	11	3	0
24-pr. ,,		7	3	21	10	3	20
18-pr. ,,		6	3	20	9	2	10
12-pr. ,,		6	1	0	8	1	12
13-in. mortar	Old pattern.	,,	,,	,,	50	1	11½
10-in. ,,	Old pattern.	,,	,,	,,	24	0	13½
8-in. ,,	Old pattern.	,,	,,	,,	21	1	5½
5½-in. ,,		1	0	10	,,	,,	,,
4⅖-in. ,,		0	3	5	,,	,,	,,
13-in. ,,	New pattern.	,,	,,	,,	31	0	0
10-in. ,,	New pattern.	,,	,,	,,	15	2	22
8-in. ,,	New pattern.	,,	,,	,,	7	2	10

TABLE XVI.

		cwt.	qrs.	lbs.	cwt.	qrs.	lbs.
Cavalry Forge Cart					10	2	18½
Flanders Waggon					15	2	0
Small Arm Ammunition Waggon.	Limber	7	2	10	34	2	4
	Body	7	0	6½			
	20 Musket-ball boxes	2	0	16			
	20,000 Rounds of musket-ball cartridges	16	1	6			
	25,000 Percussion caps	0	1	12			
	29 Paper boxes for do.	0	0	10			
	15 sets of Horse-shoes, with nails	0	3	14			
	1 Horse-shoe box	0	0	13½			
Note.—When flints are sent in lieu of percussion caps, the weight would be for	2000 Flints	0	2	16	0	3	9½
	2 Flint boxes	0	0	21½			
Sling Cart					16	1	17
Sling Waggon, Improved, substituted for the Large Devil Carriage					31	0	23
Gyns, Triangle.	Large	9	2	22½	12	2	19½
	Blocks, &c.	2	3	25			
	Small	7	3	3	10	2	4
	Blocks, &c.	2	3	1			
Platform Waggon					21	1	23
Devil Carriage, complete, small					7	2	8
Baggage Cart					9	0	8
Store Limber Carriage.	Body	10	3	8	18	3	18
	Limber	8	0	10			
Blanshard's Pontoon large Carriage		13	2	24	42	2	12
	Appurtenances	28	3	16			
Ditto ditto small Carriage		9	0	0	22	2	5
	Appurtenances	13	2	5			
Hand Cart					4	3	4

* From Griffiths' 'Artillerist's Manual,' third edition.



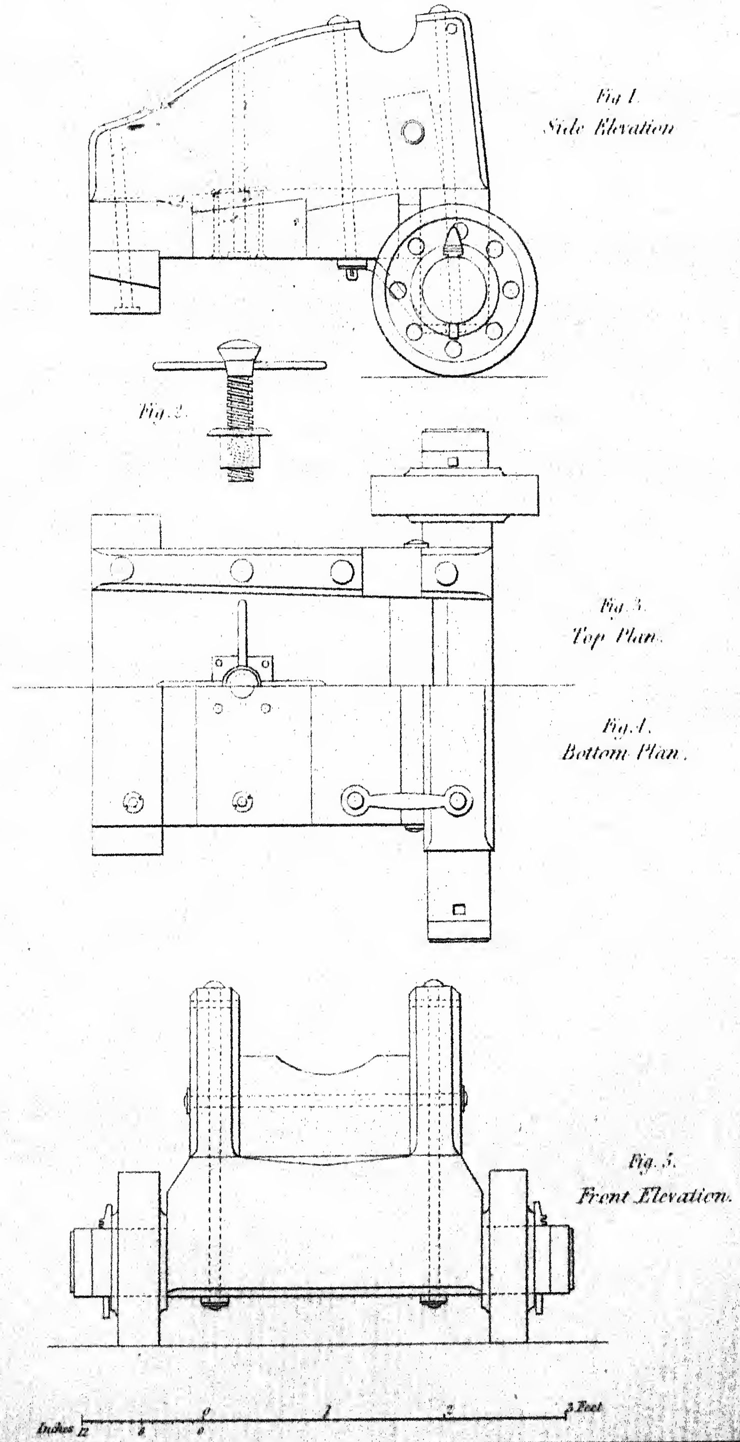
T. H. Hodgson del.
Serg.t Royal Artillery.

J. W. Lowry fc.

John Weale, 59, High Holborn 1844.

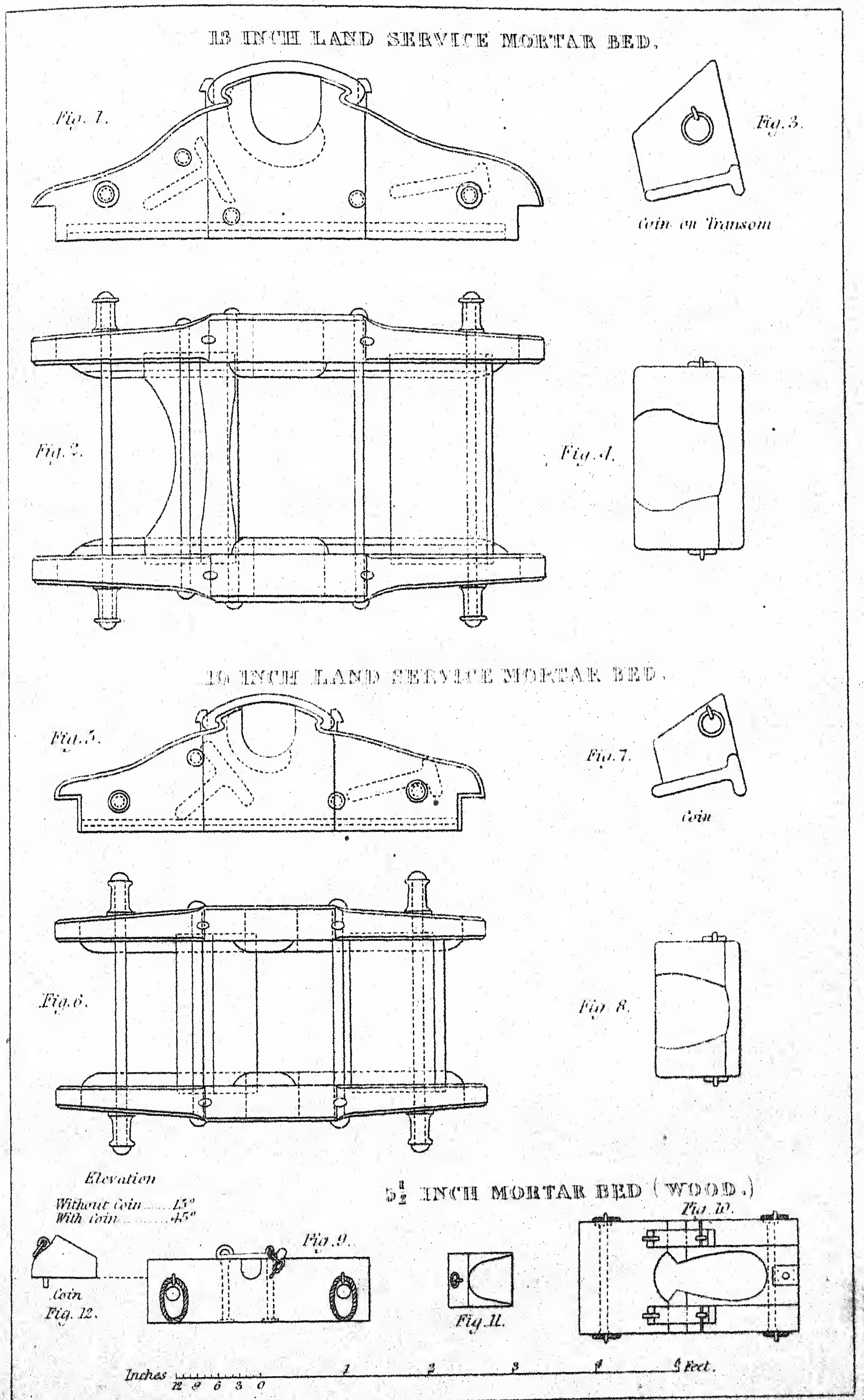
24 POUNDER HOWITZER.

GARRISON CARRIAGE.



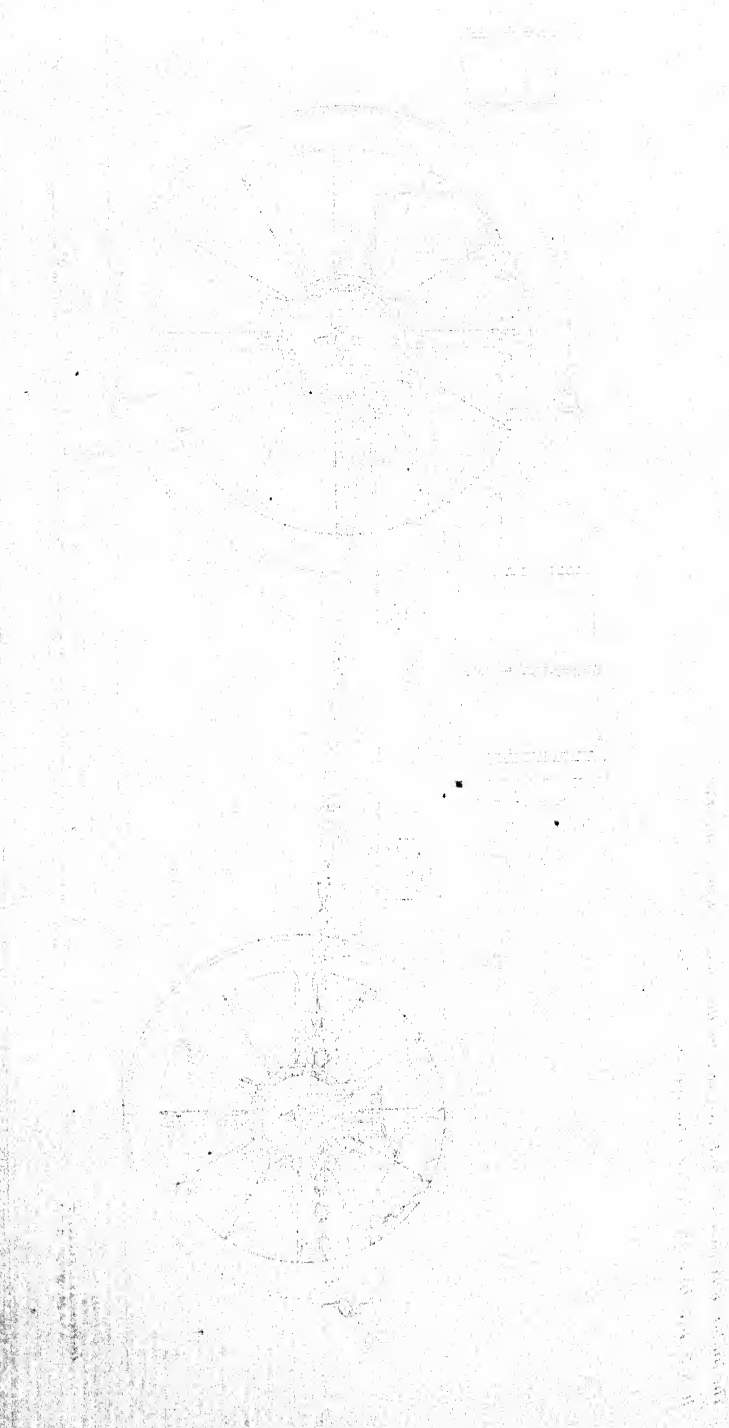
G. D. Dempsey del.

J. W. Lowry fc.



J. Taylor. J. W. Lowry fc.

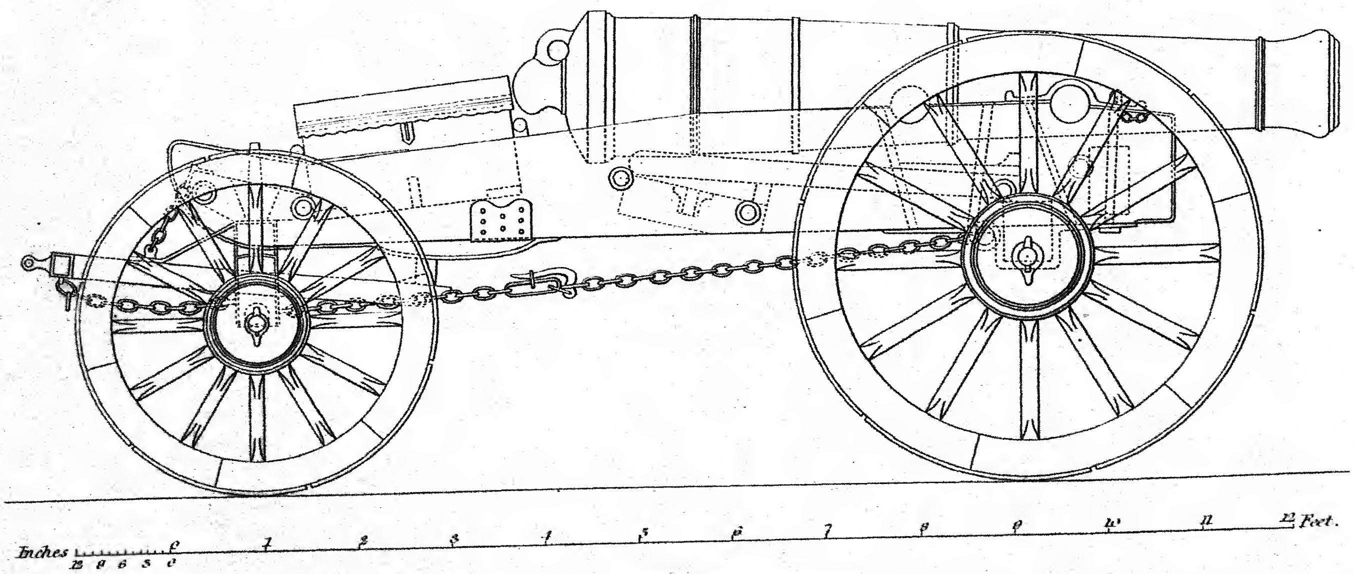
London John Weale 59 High Holborn 1852.



13 POUNDER.

Elevation.

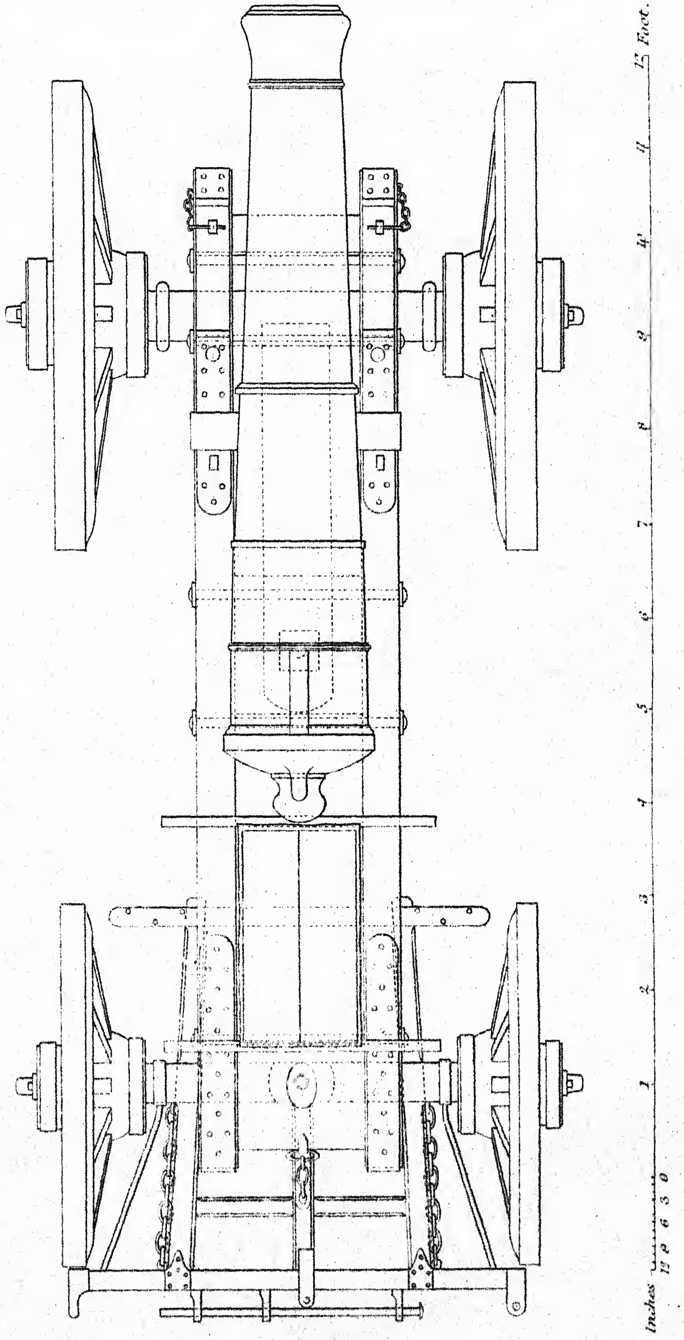
The limber here shewn (completed except the Shafts) serves for the 10 & 8 inch Iron Howitzers and for the 24 P. Iron siege Gun.



J. Taylor.
J. W. Lowry fc.
London, John Weale 59 High Holborn 1852.

18 POUNDER.

Plan.

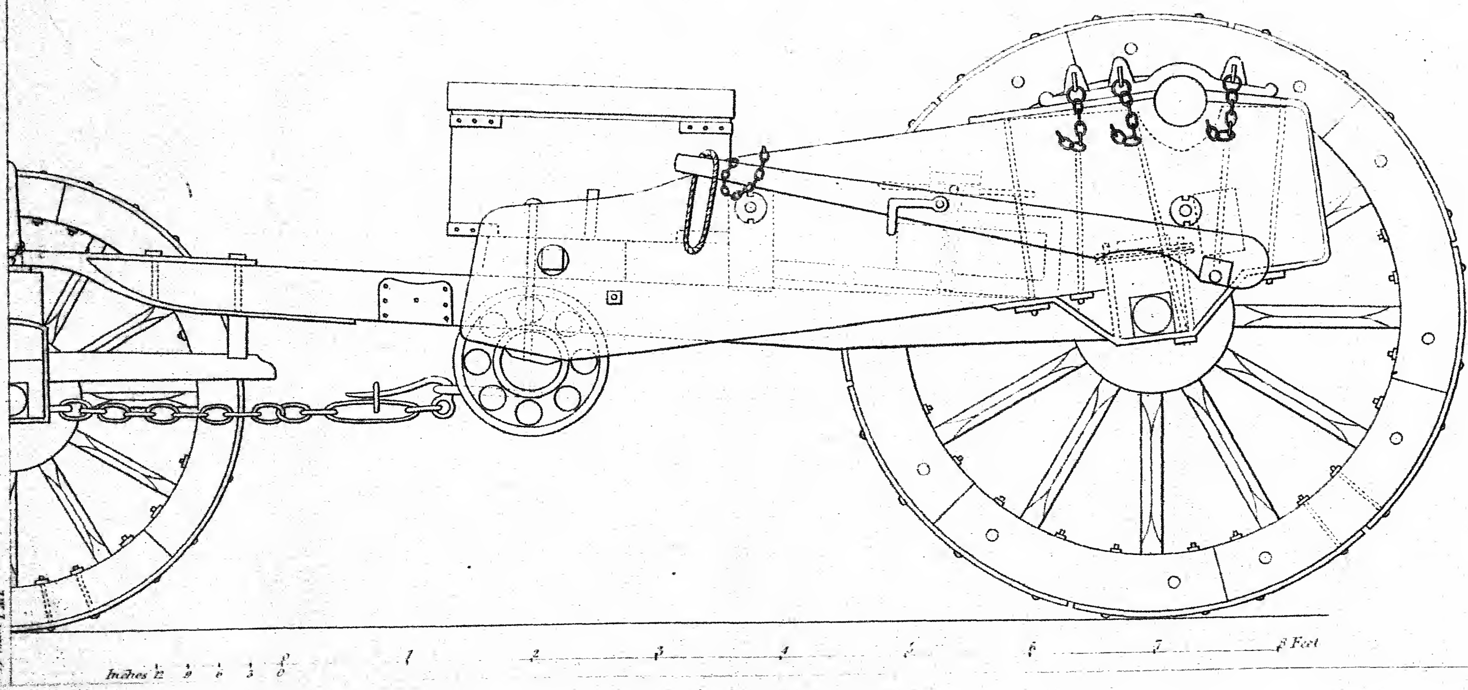


J. Taylor. J. W. Lowry fc.

London John Weale 59 High Holborn 1852.

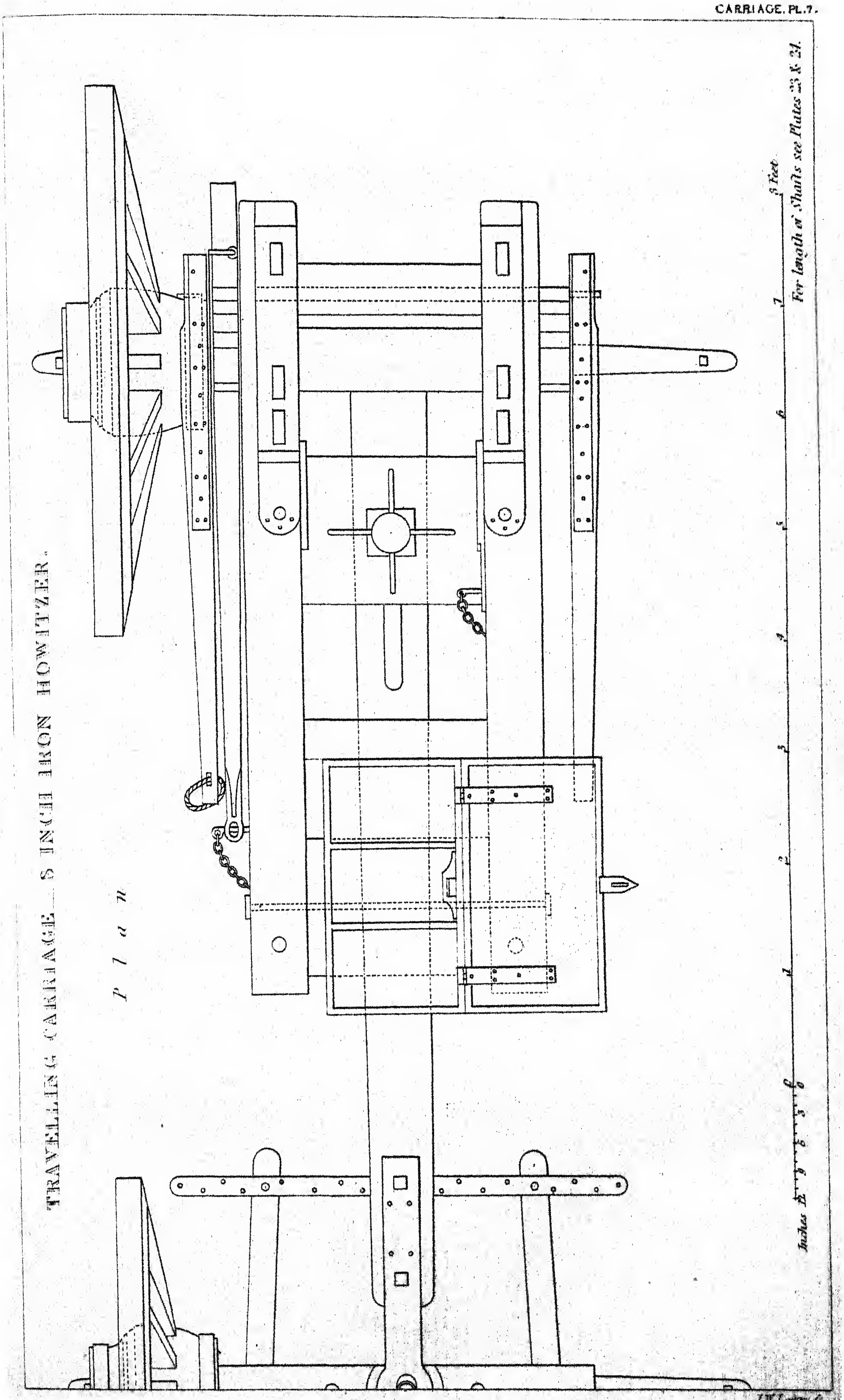
TRAVELLING CARRIAGE 8 INCH IRON HOWITZER.

Elevation



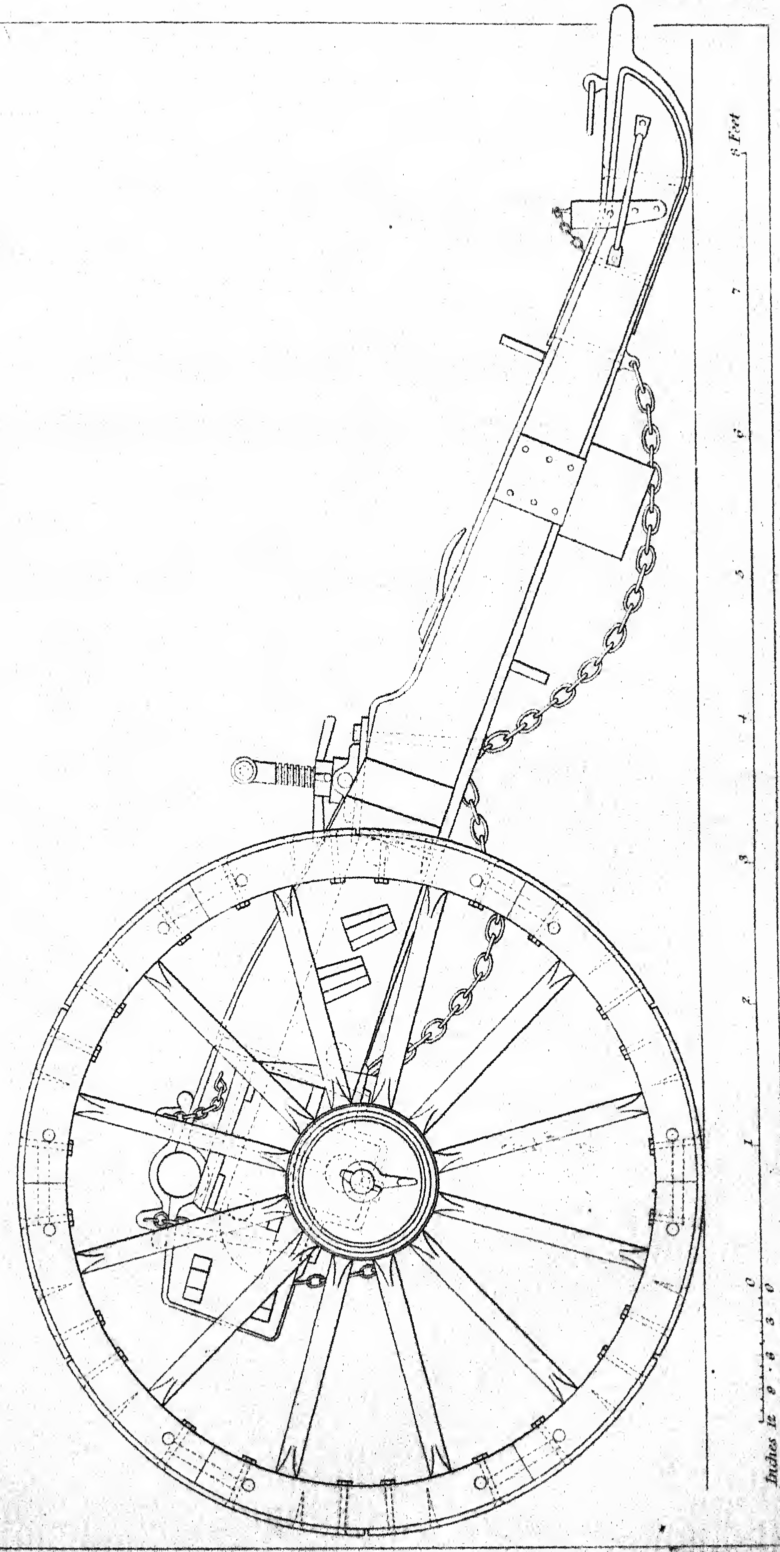
J.W. Lowry fc.

John Weale, 59, High Holborn, 1845.



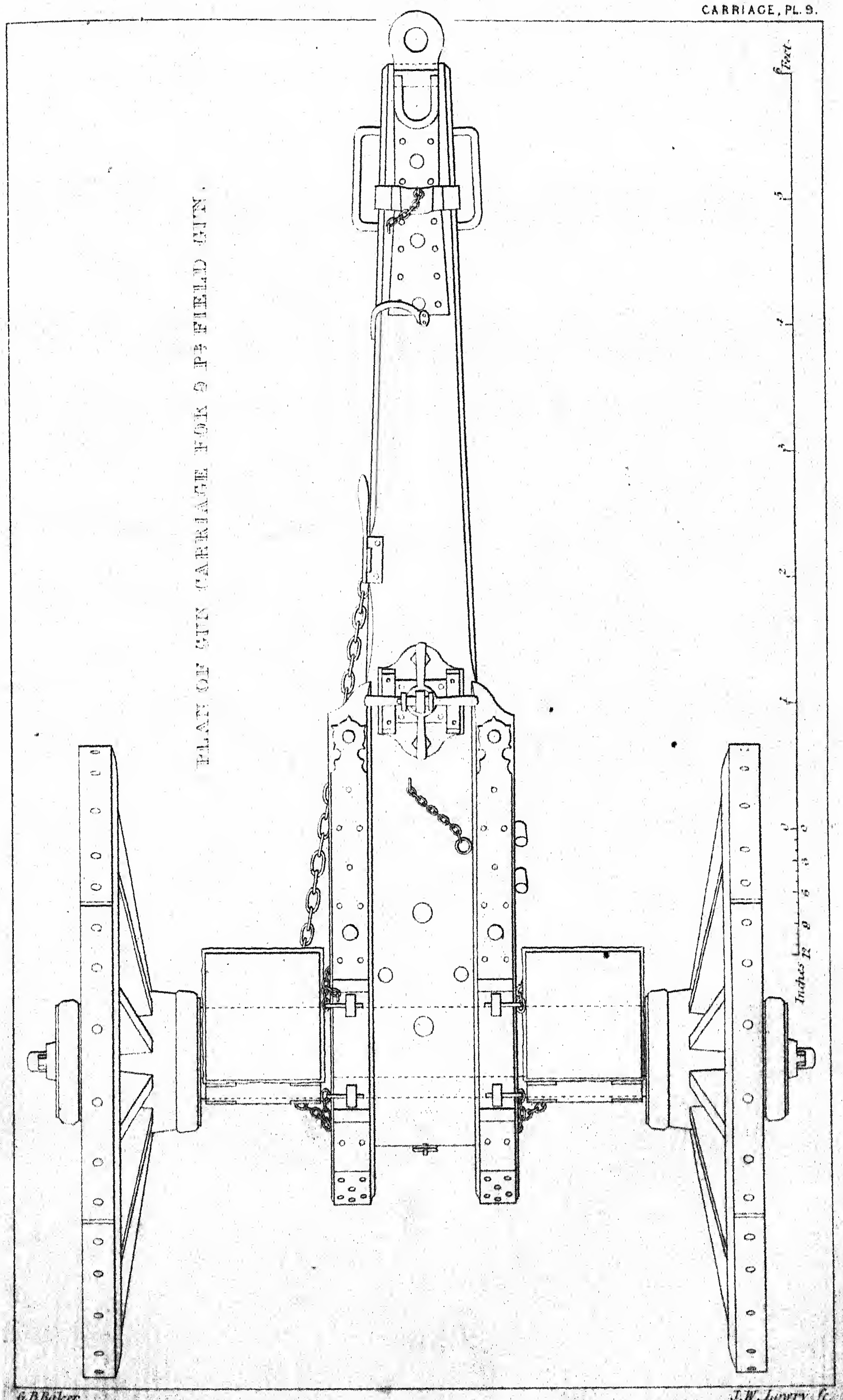
John Weale 59 High Holborn, 1845.

ELEVATION OF GUN CARRIAGE FOR 9 Pr FIELD GUN.



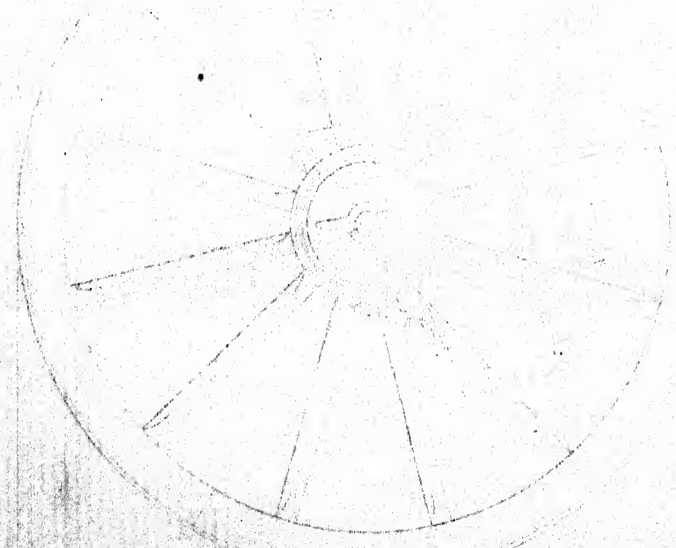
G.B. Baker. J.W. Lowry fc.

John Weale 59 High Holborn 1852.

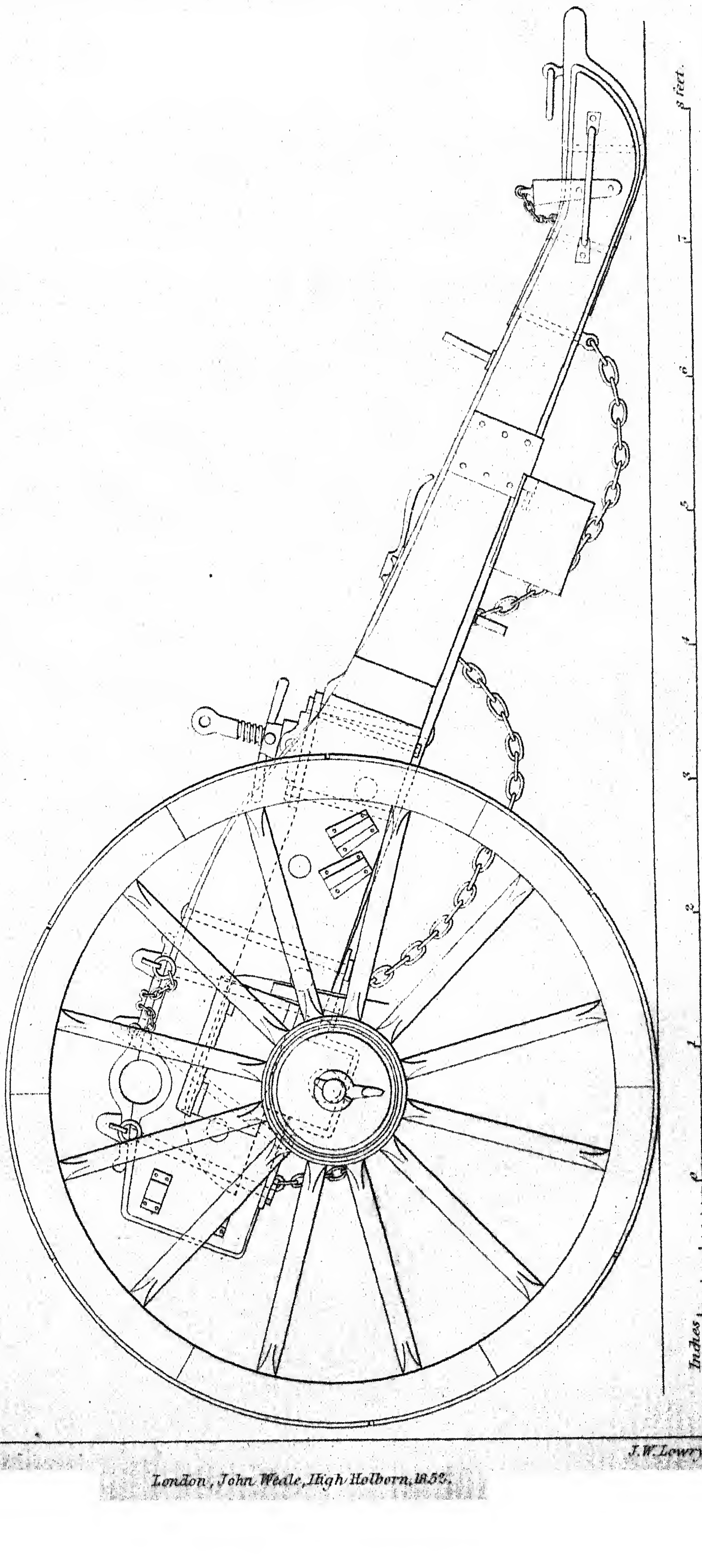


G. B. Baker. J. W. Lowry sc.

London. John Weale High Holborn 1852.

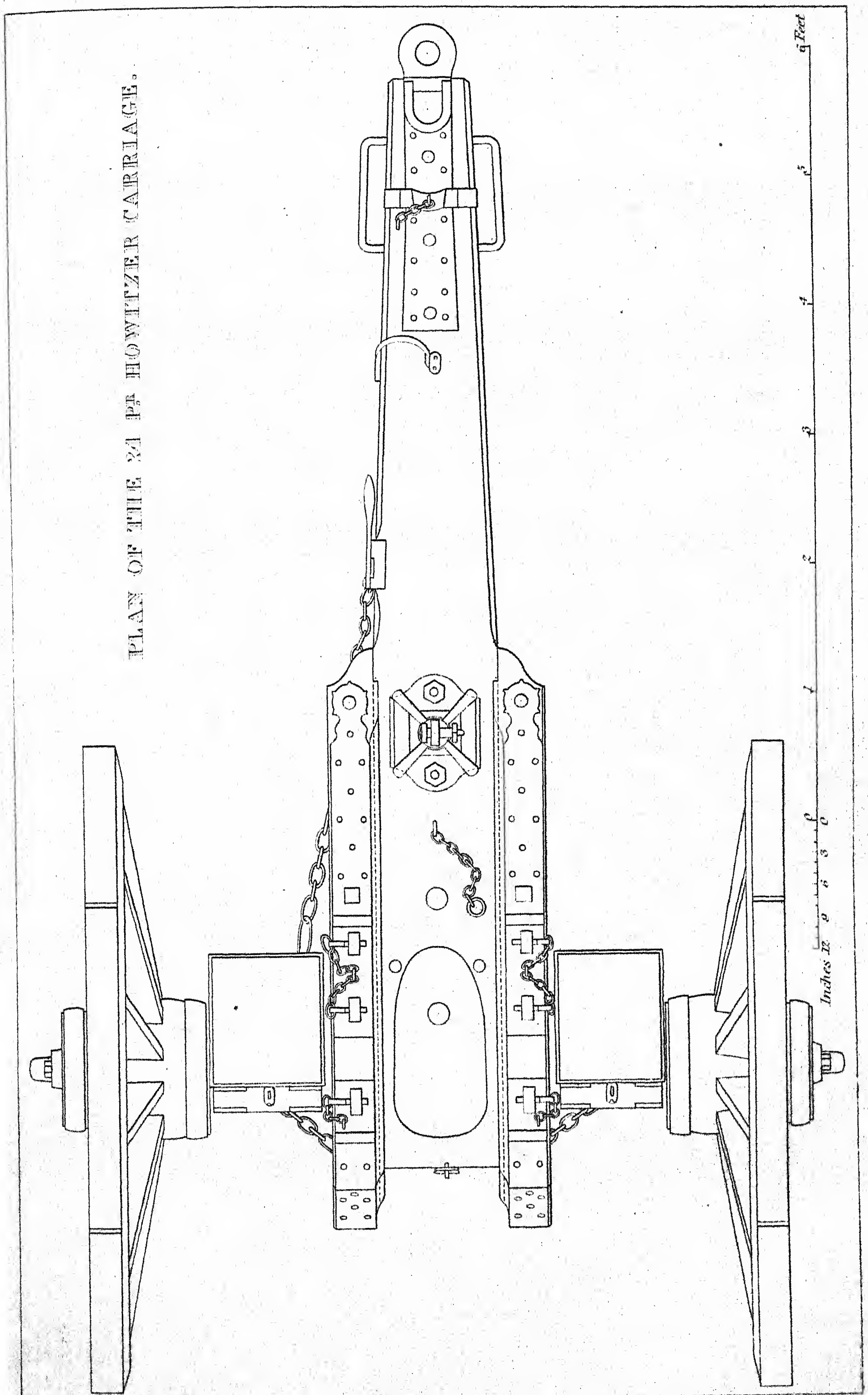


ELEVATION OF THE 24 Pr. HOWITZER CARRIAGE.



G. R. Baker. J. W. Lowry fc.

London, John Weale, High Holborn, 1852.

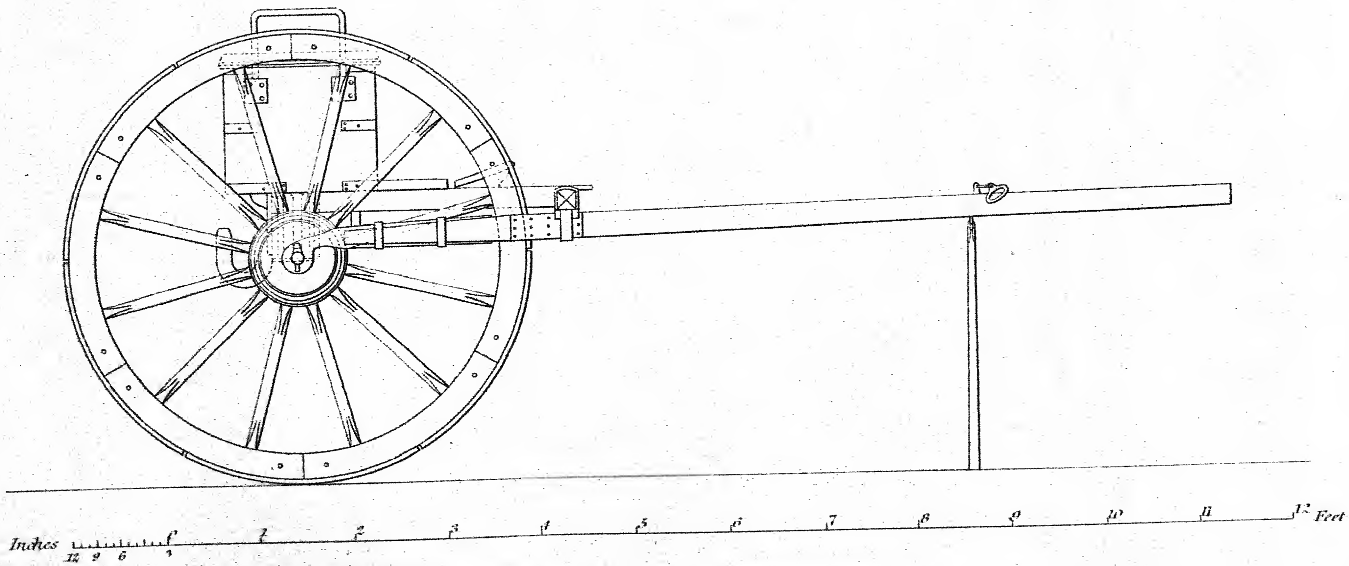


PLAN OF THE 24 Pr. HOWITZER CARRIAGE.

G. B. Baker. J. W. Lowry fc.

John Weale, 59, High Holborn, 1852.

ELEVATION OF LIMBER 9 Pr FIELD GUN.

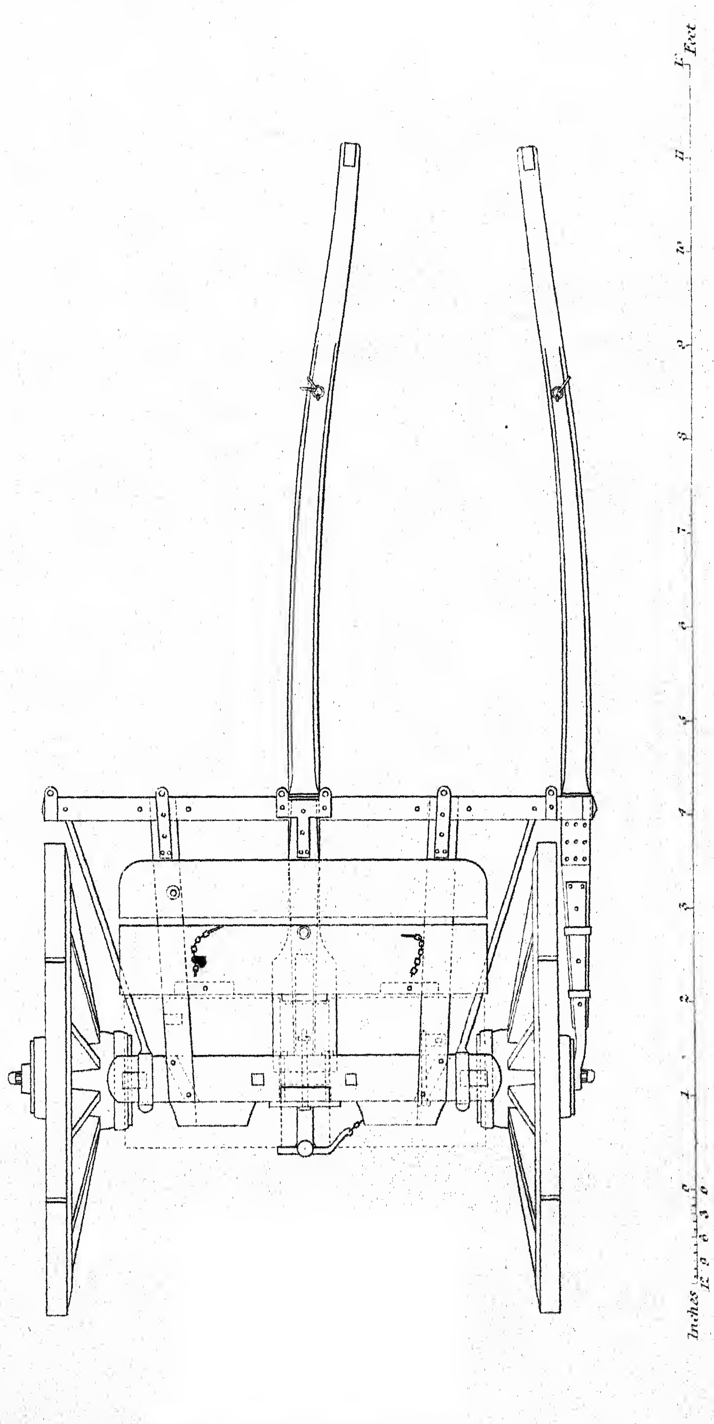


G. B. Baker.

J. W. Lowry fc.

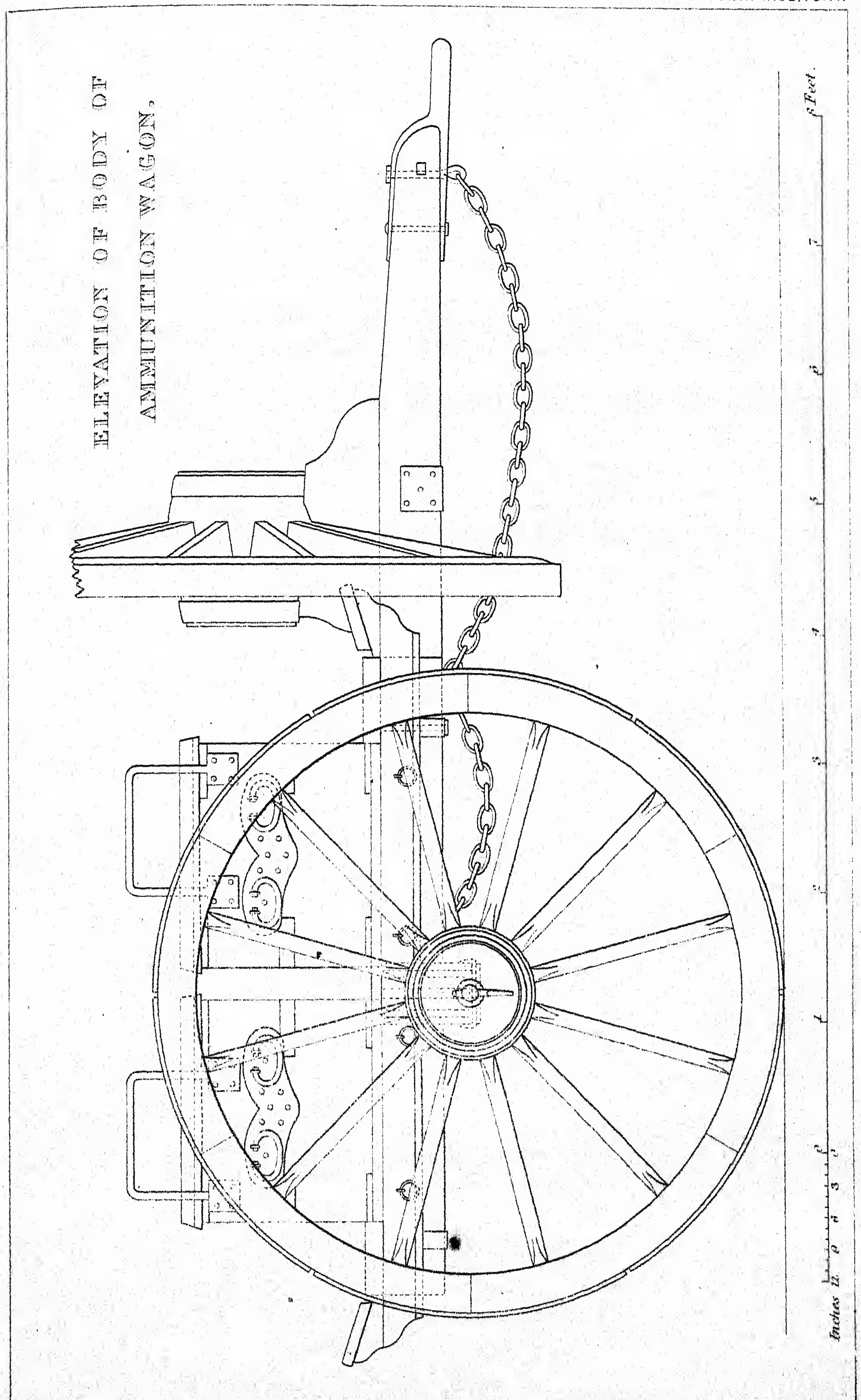
London, John Weale, 59, High Holborn, 1852.

PLAN OF LIMBER 9 P^{r} FIELD GUN.



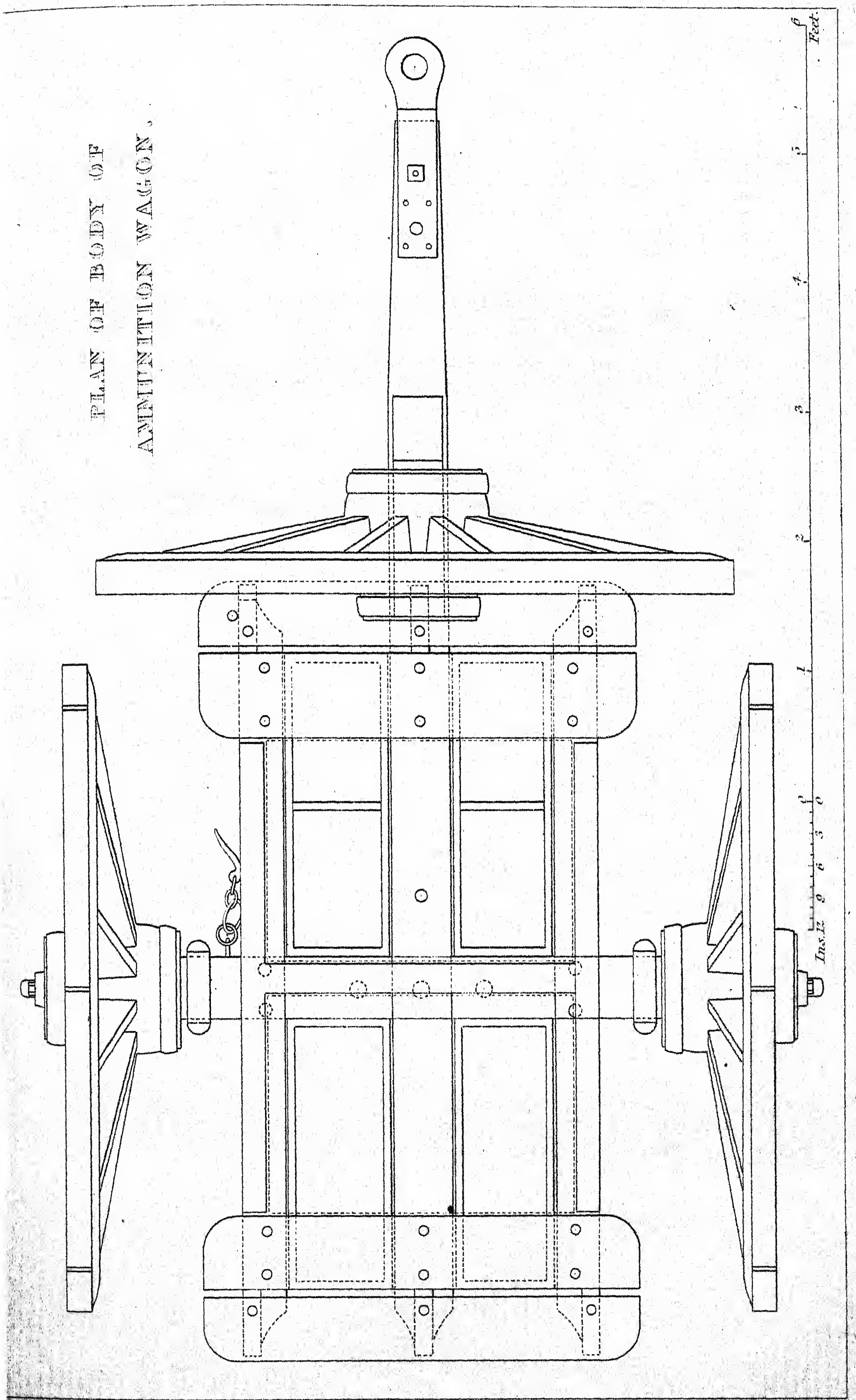
G. B. Baker. J. W. Lowry fc.

London, John Weale 59 High Holborn 1852.



G. B. Baker. J. W. Lowry fc.

John Weale 59 High Holborn 1852.



PLAN OF BODY OF AMMUNITION WAGON.

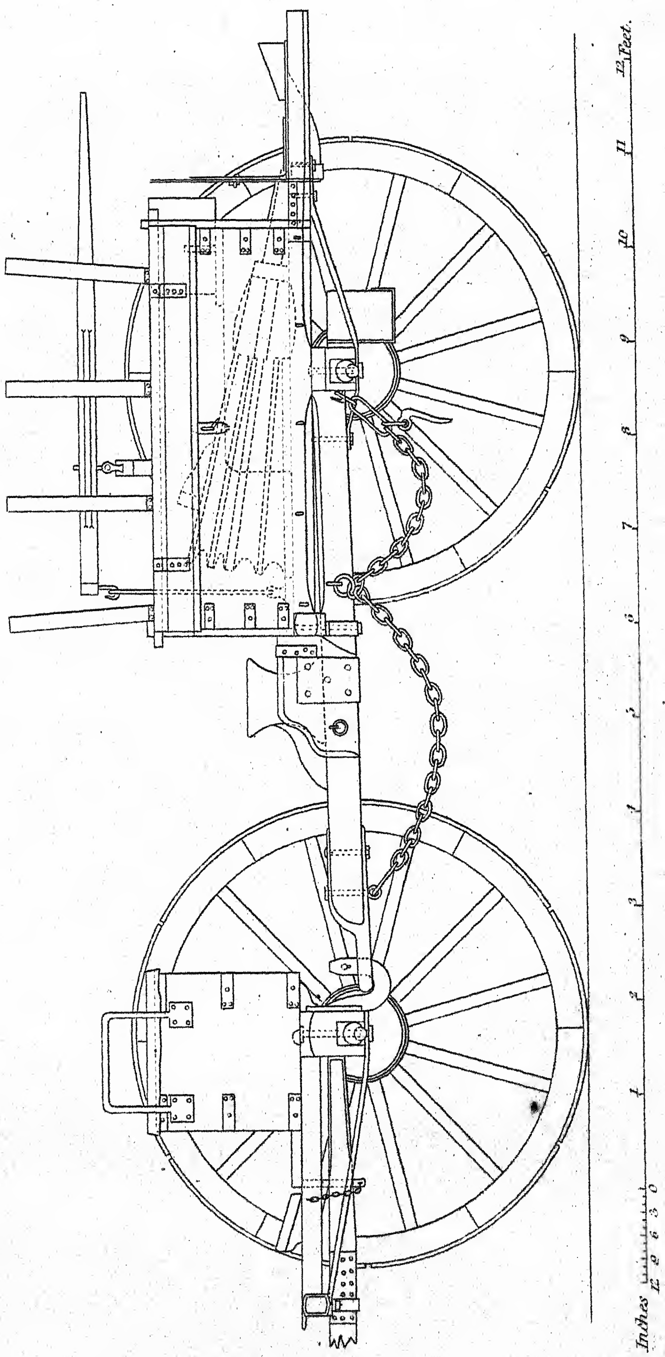
G.B. Baker.

J.W. Lowry fc.

John Weale, 59, High Holborn, 1852.

FORGE WAGON.

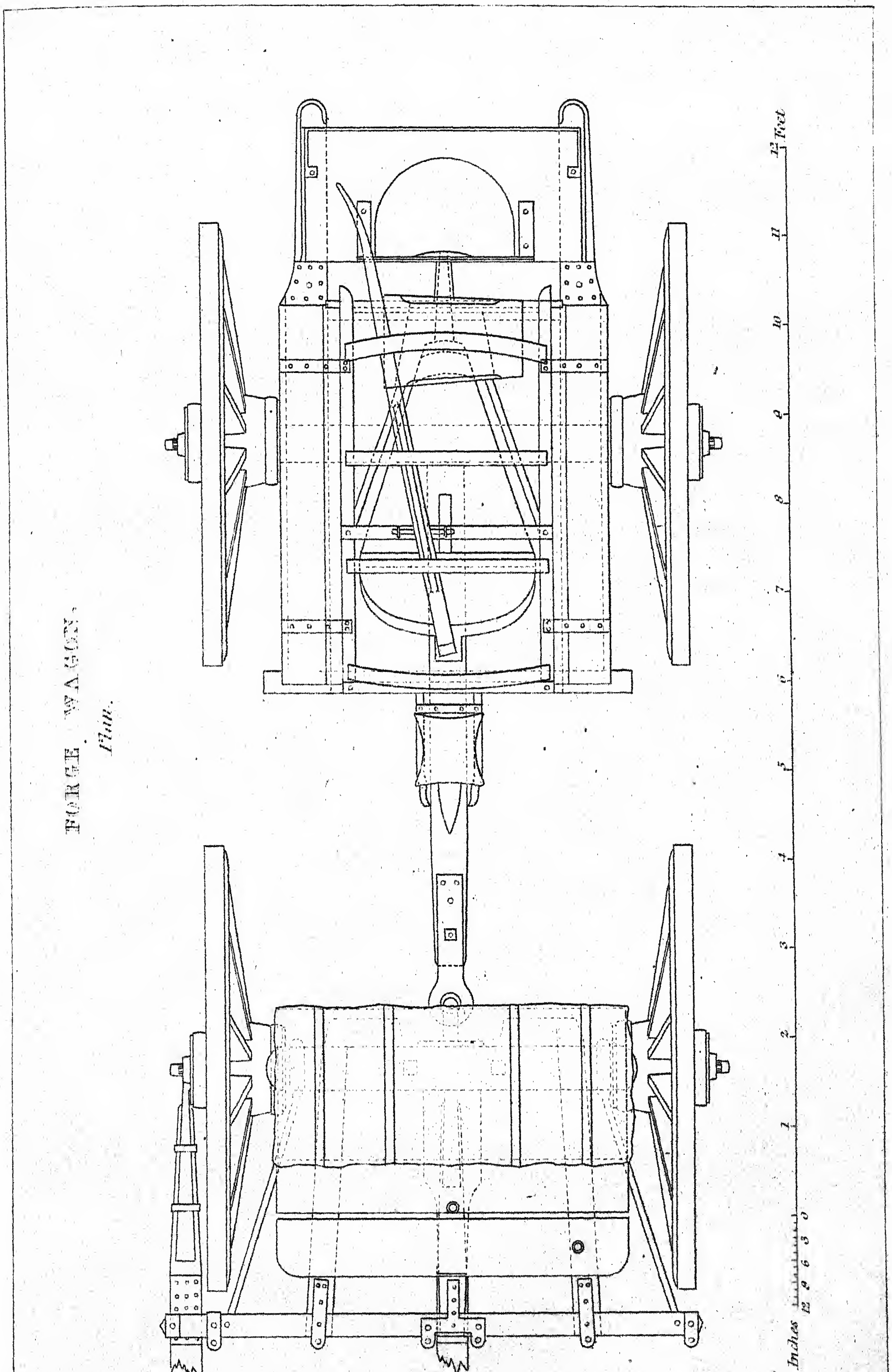
Side Elevation.



G. B. Baker.

J. W. Lowry fc.

London, John Weale 59 High Holborn 1852.



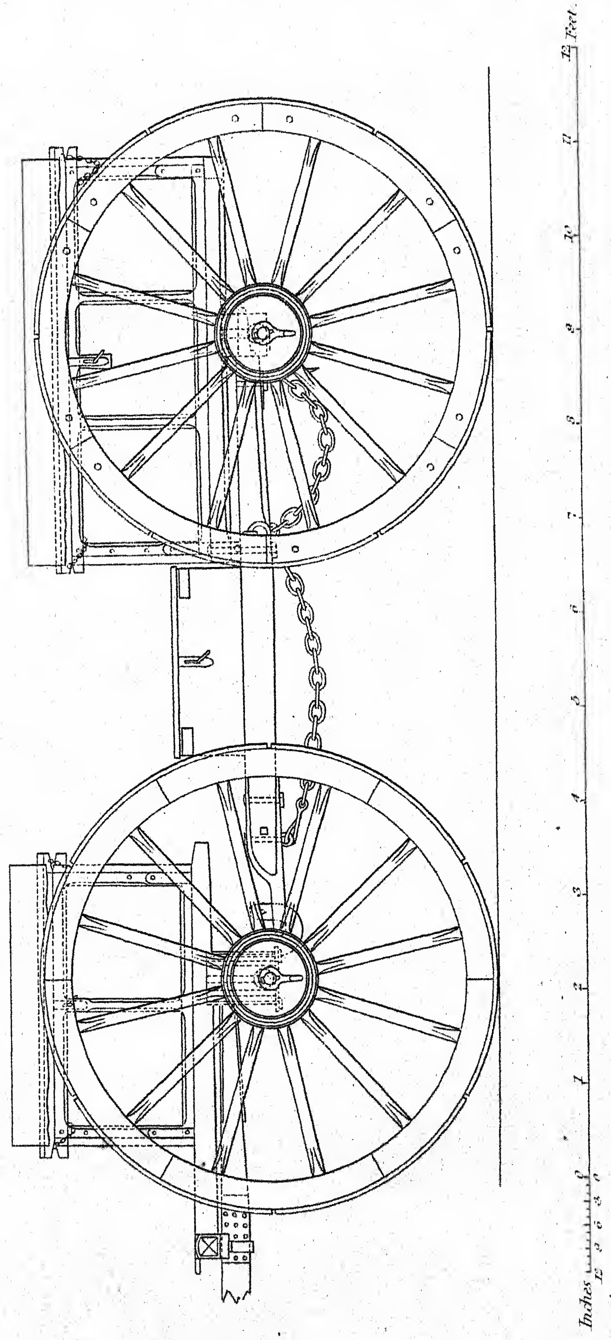
FORGE WAGON.
Plan.

G. B. Baker

J. W. Lowry fc.

London, John Weale, 59, High Holborn, 1852.

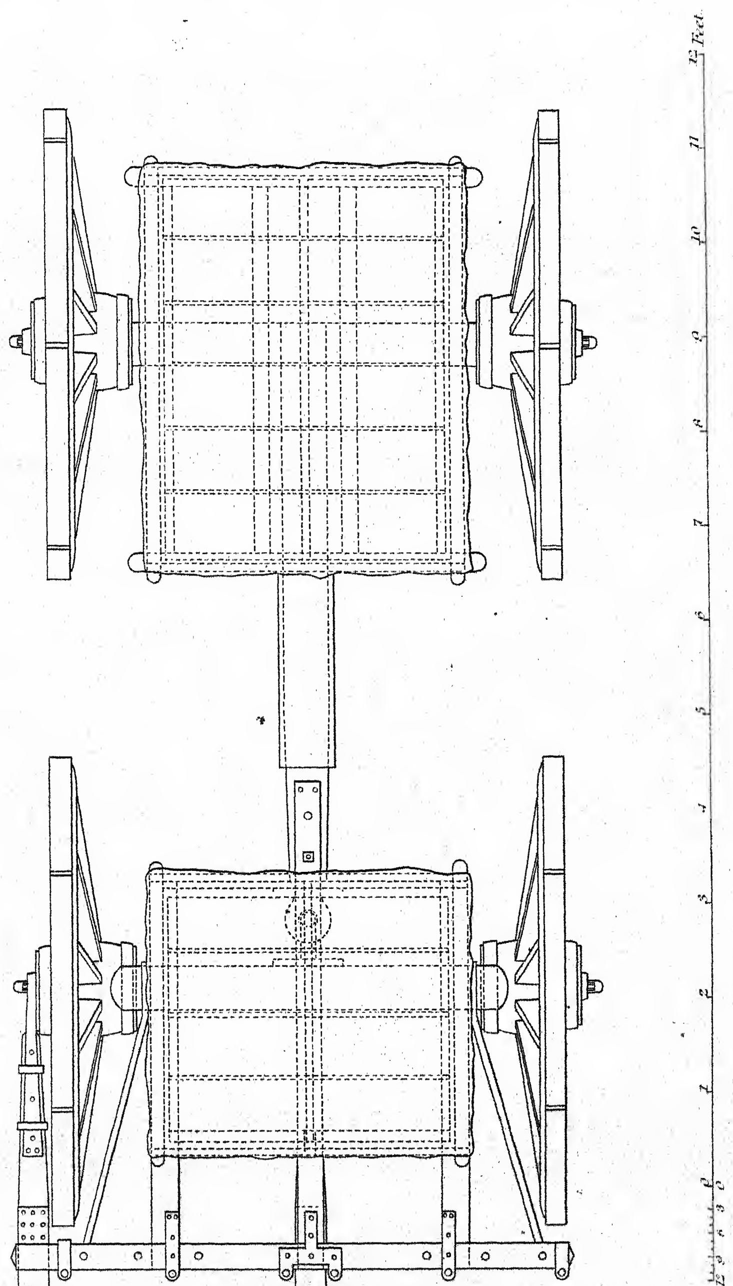
ELEVATION OF SMALL ARM AMMUNITION WAGON.



G. B. Baker. J. W. Lowry fc.

London, John Weale, 59, High Holborn, 1852.

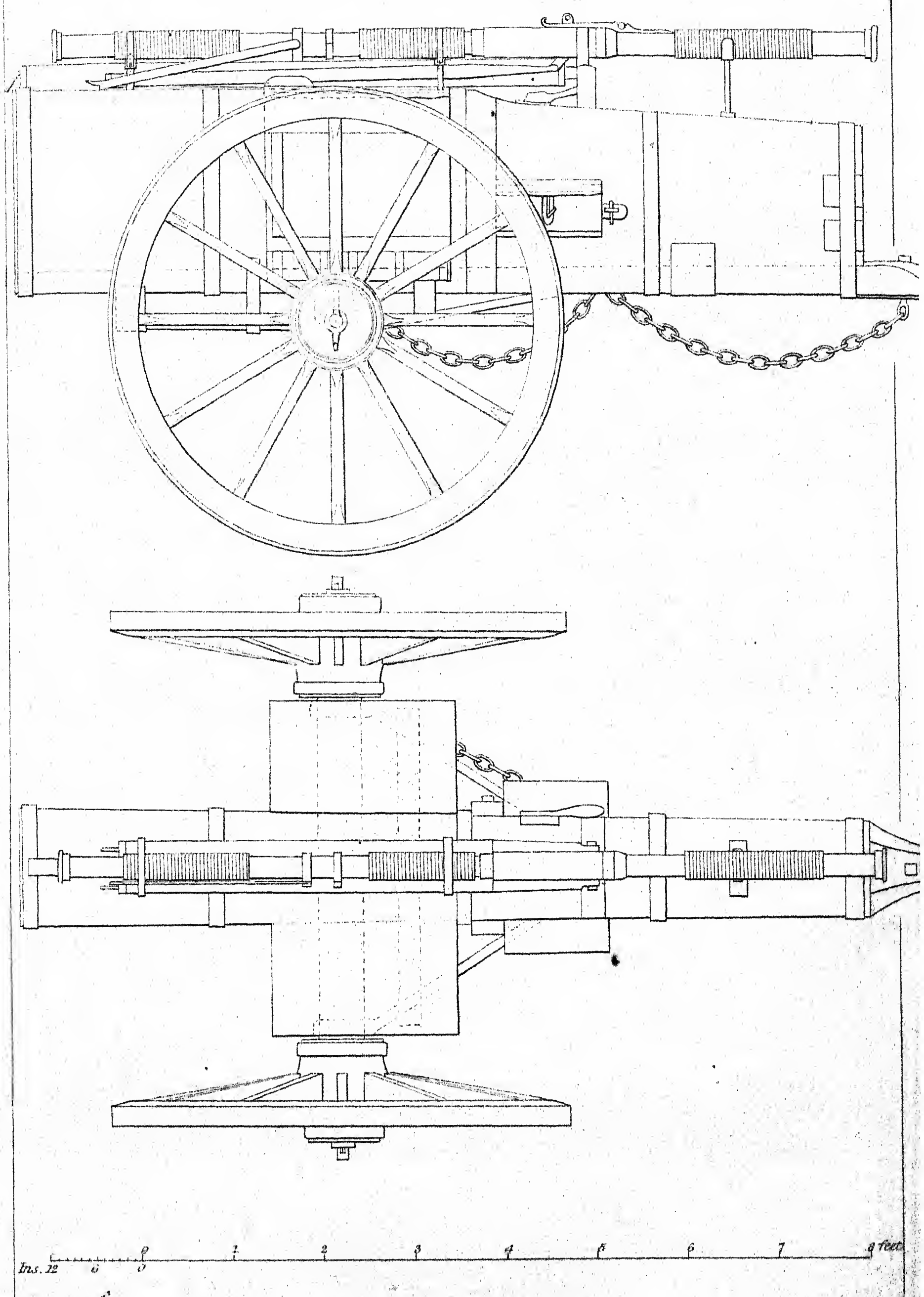
PLAN OF SMALL ARM AMMUNITION WAGON.



G. B. Baker. J.W. Lowry sc.

London, John Weale 59 High Holborn 1852.

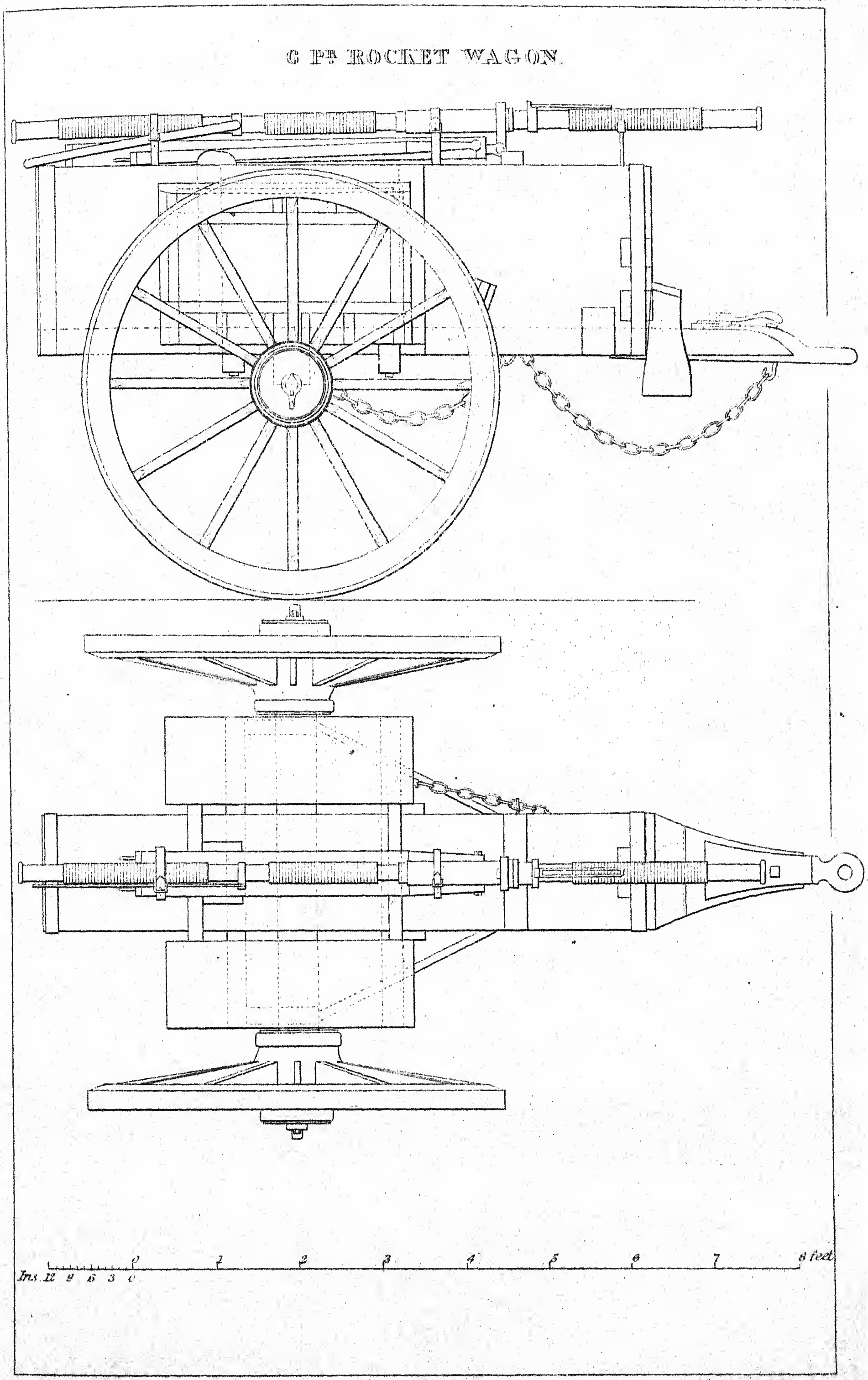
12 P^D.^ ROCKET WAGON.



G.B. Baker. J.W. Lowry fc.

London, John Weale 59 High Holborn 1852.

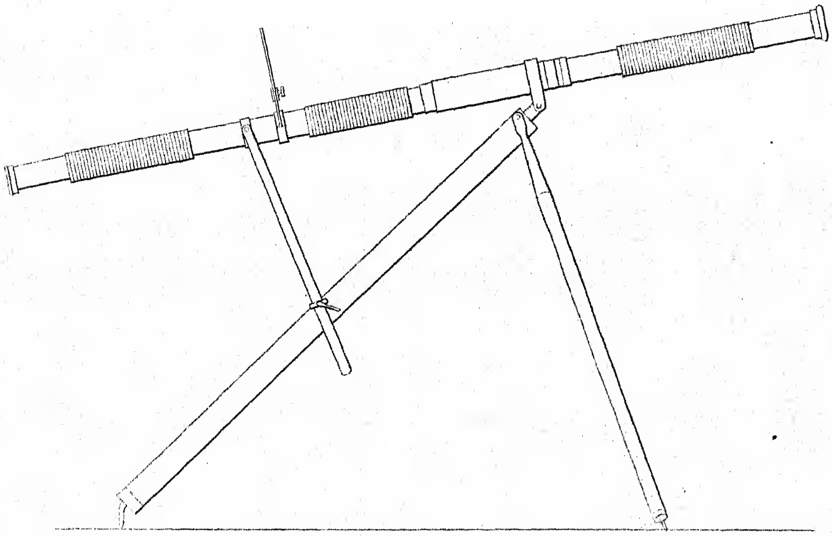
6 Pr. ROCKET WAGON.



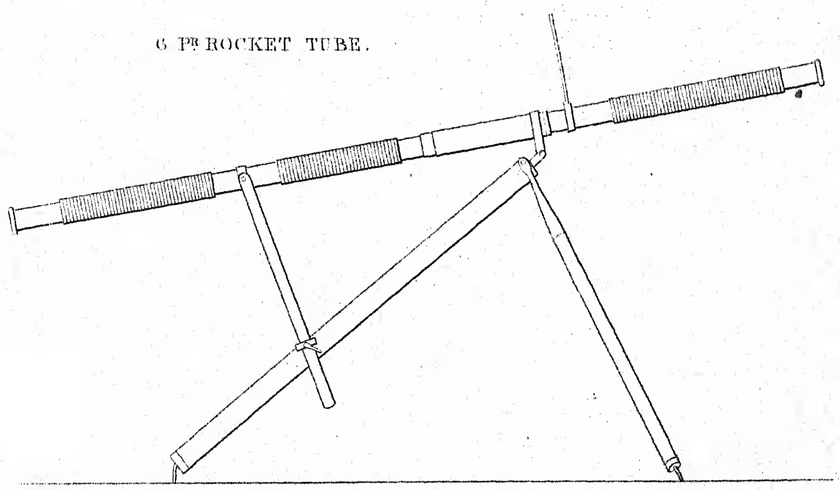
G. B. Baker. J. W. Lowry fc.

John Weale 59 High Holborn 1852.

12 P^R ROCKET TUBE.



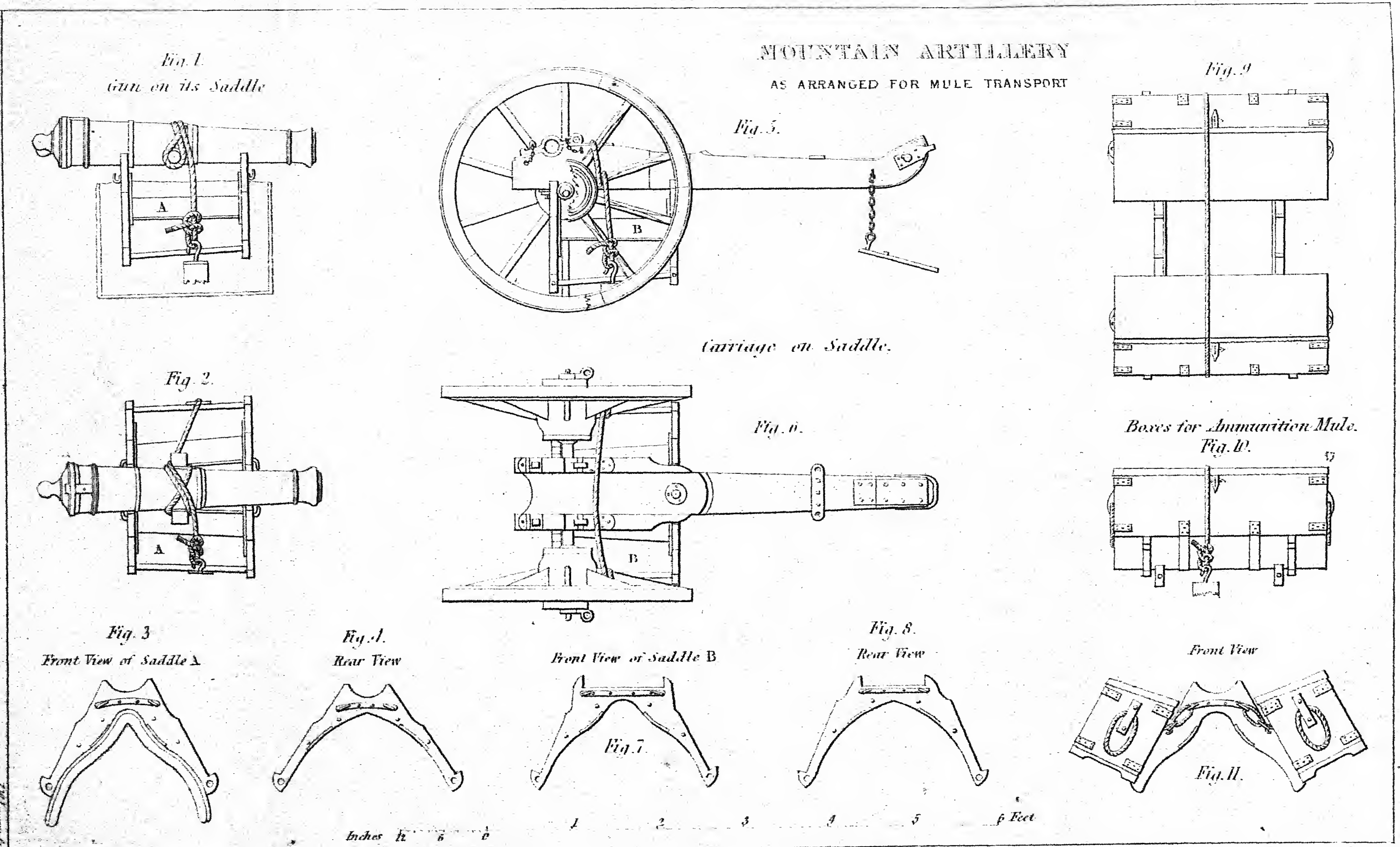
6 P^R ROCKET TUBE.



G.B. Baker.

J.W. Lowry fc.

John Weale 59 High Holborn 1852.



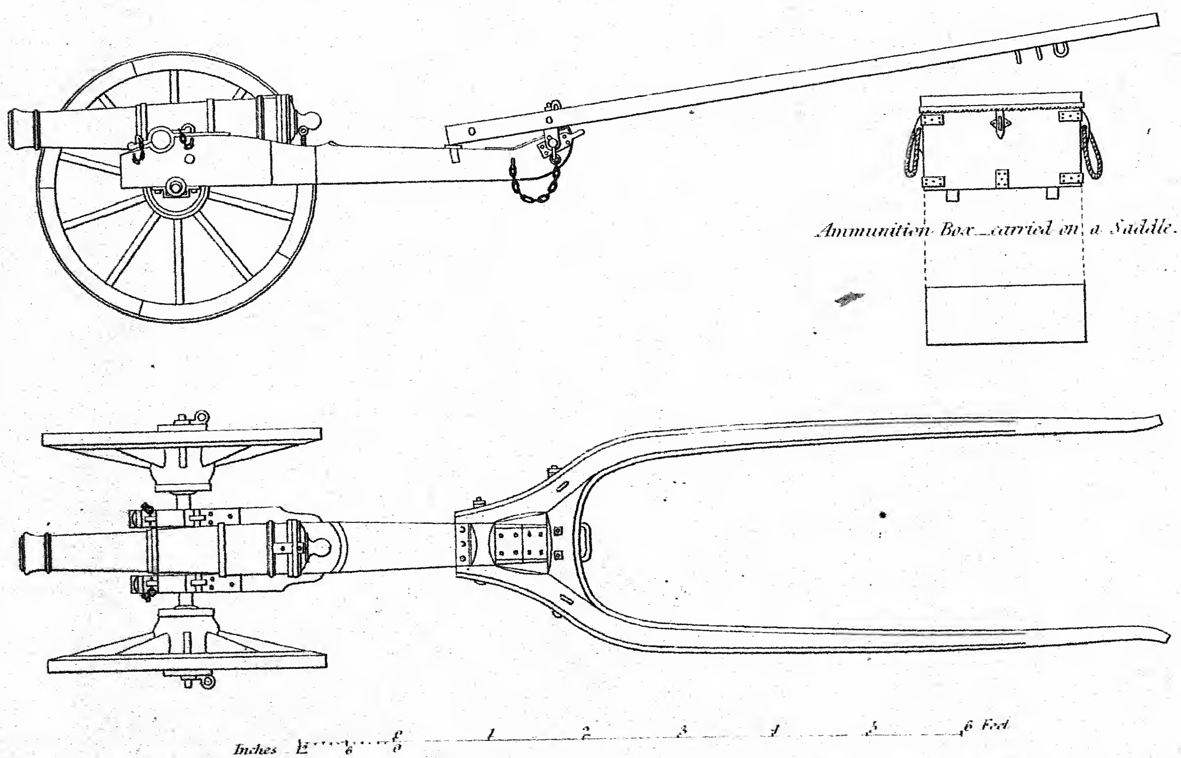
T. H. Hodgson del.
Serg^t. Royal Artillery.

J. W. Lowry fc.

John Weale, 59 High Holborn, 1865

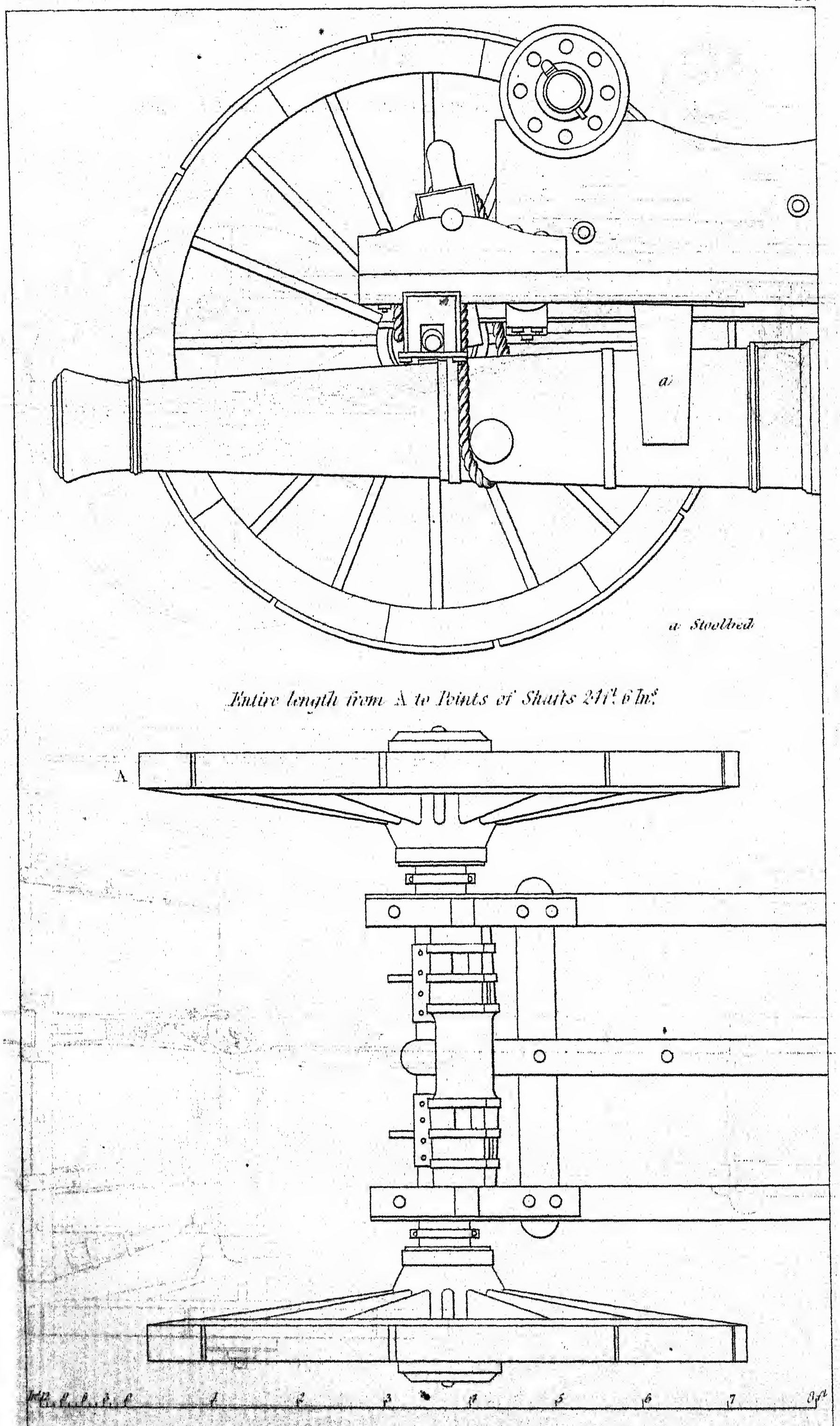
ELEVATION & PLAN OF A LIGHT 3 POUNDER (MOUNTAIN SERVICE.)

SHAFT TO THE TRAIL



T.H. Hodgson del.
Serj.t Royal Artillery

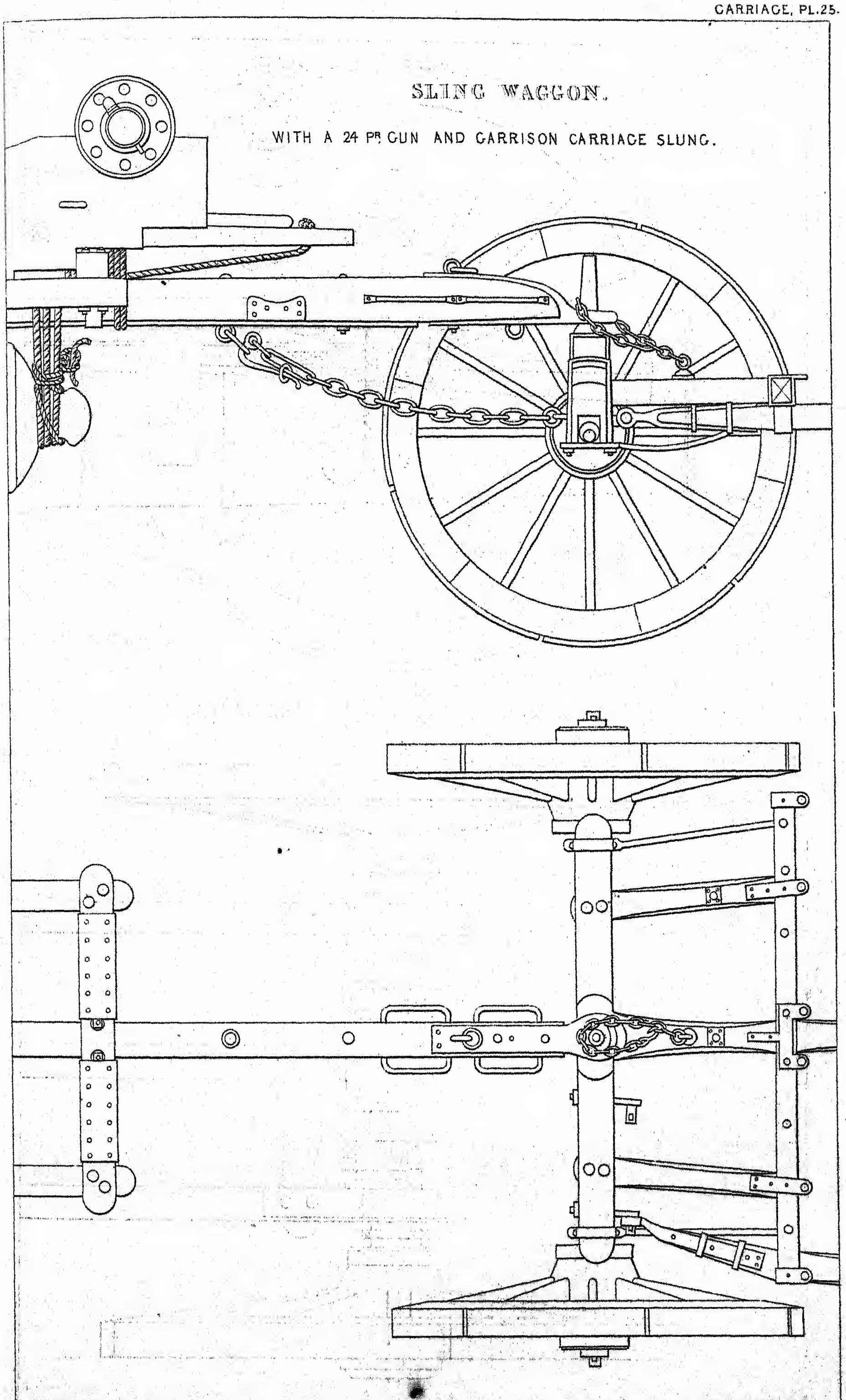
J.W. Lowry fe.



T. Hodgson, Delt.
Sergt. Royal Artillery

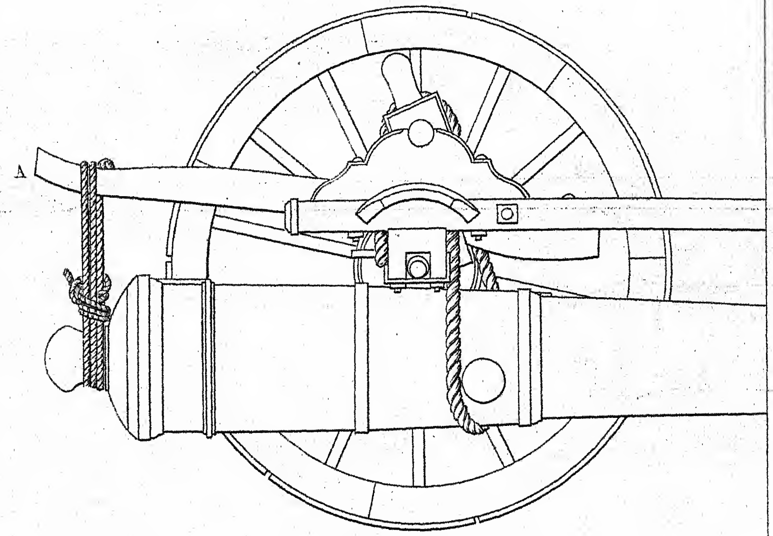
SLING WAGGON.

WITH A 24 P^R GUN AND GARRISON CARRIAGE SLUNG.

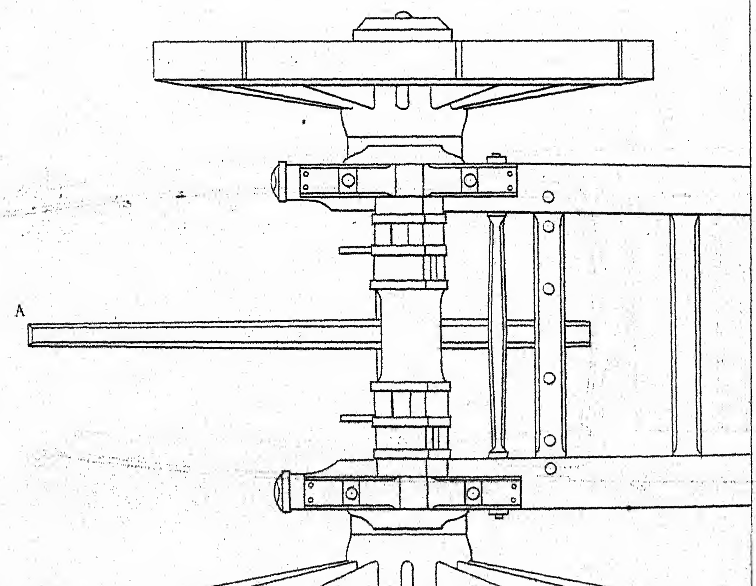


J.W. Lowry fc.

John Weale 59 High Holborn 1844.



Entire length A B 17 feet.

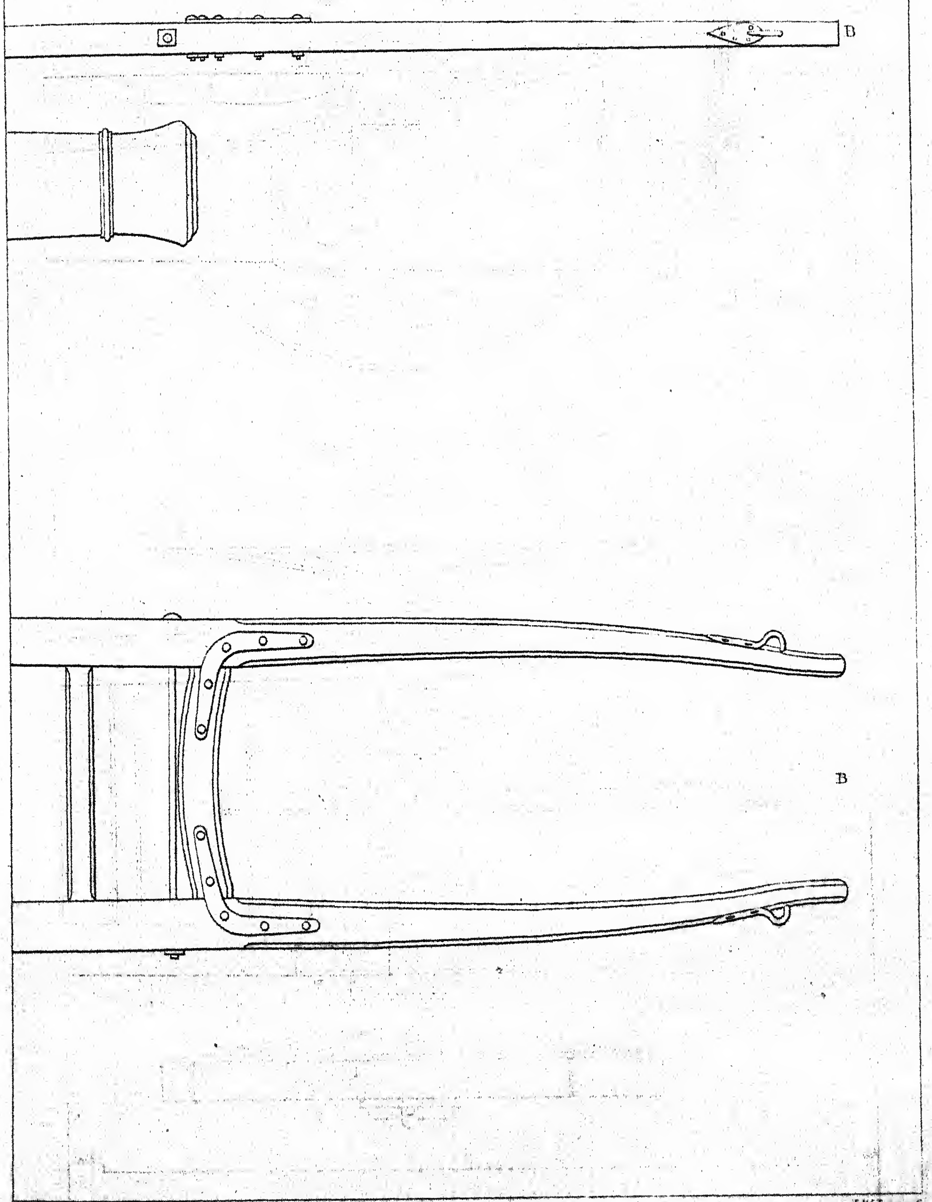


Inches 12 9 6 3 0 1 2 3 4 5 6 7 feet

T. Hodgson del.t
Serg.t Royal Artillery.

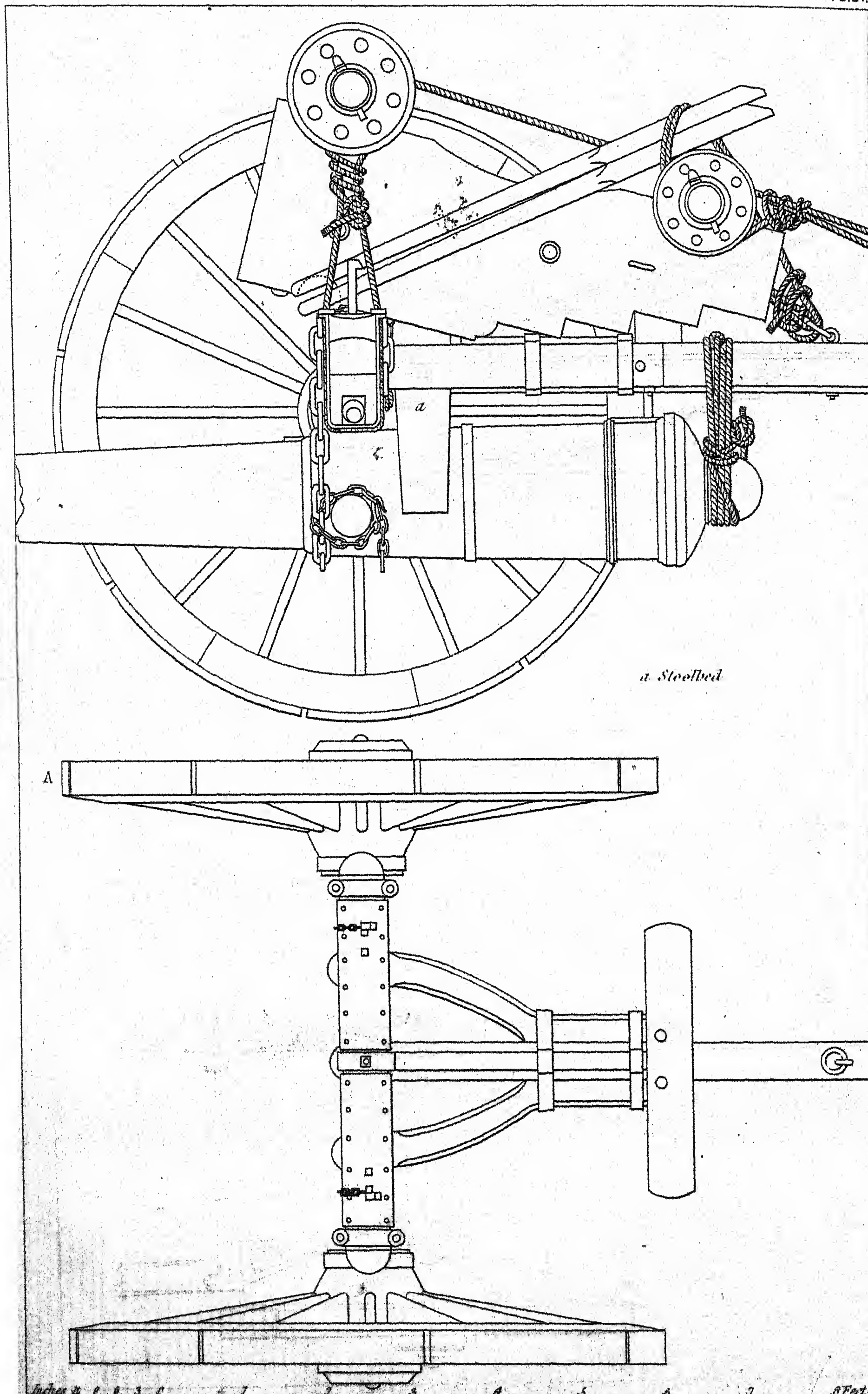
SLING CART.

WITH A 24 P^r GUN SLUNG.



J.W. Lowry fc.

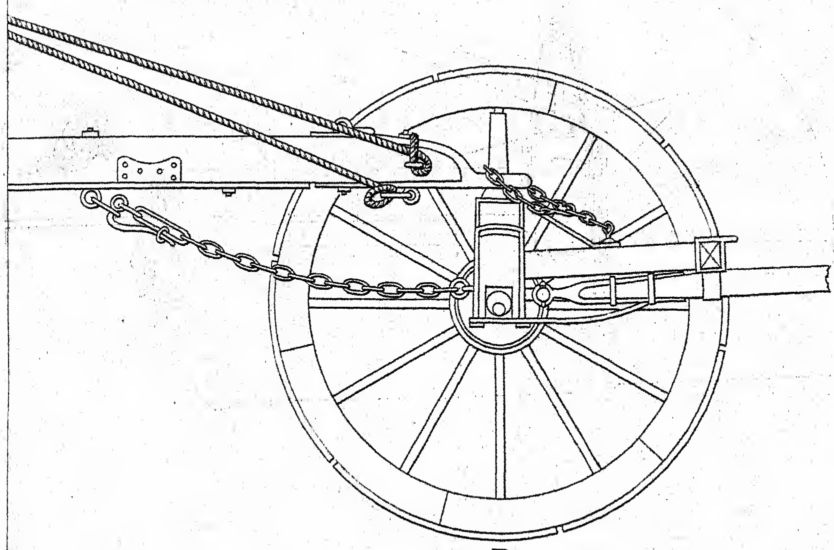
John Weale, 59, High Holborn 1844.



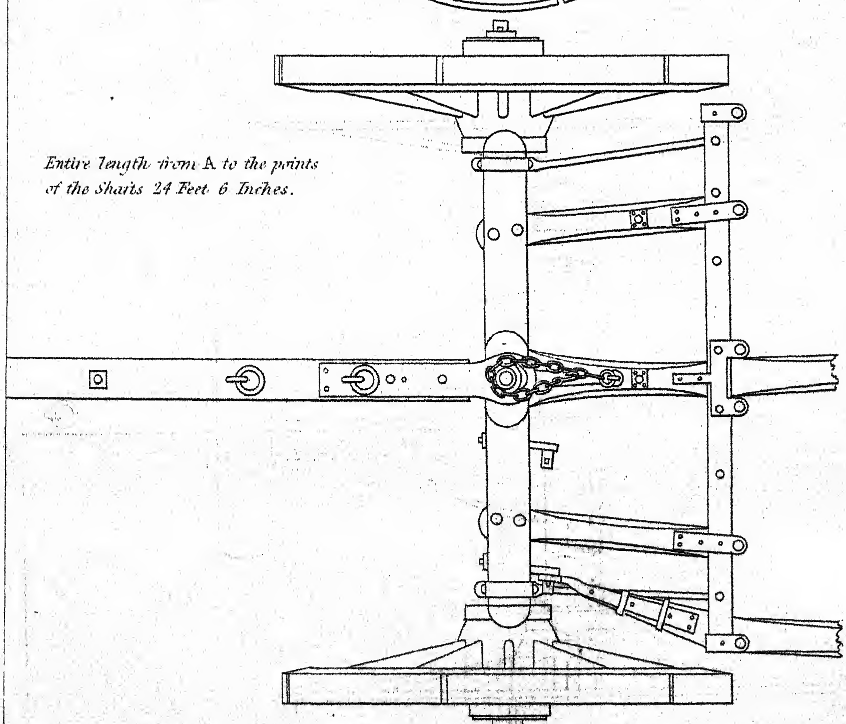
T. H. Hodgson del.
Serg^t Royal Artillery.

DEVIL CARRIAGE

WITH A 24 PR. GUN & GARRISON CARRIAGE SLUNG.



Entire length from A to the points of the Shafts 24 Feet 6 Inches.



J.W. Lowry fc.

John Weale, 59, High Holborn, 1844.

CARRIAGE FOR A PRUSSIAN 12 P^{R} GIVING 40° DEPRESSION.

a Pin attached to B and sliding along a groove e (Fig. 2) in A so that the Gun may be turned round for loading, on the bolt s being drawn.
b Moveable transom with elevating screw dropped into the notches f f
c Spring catch to retain B when recoiled
d Supports for the man laying the Gun to stand on
g Iron bar

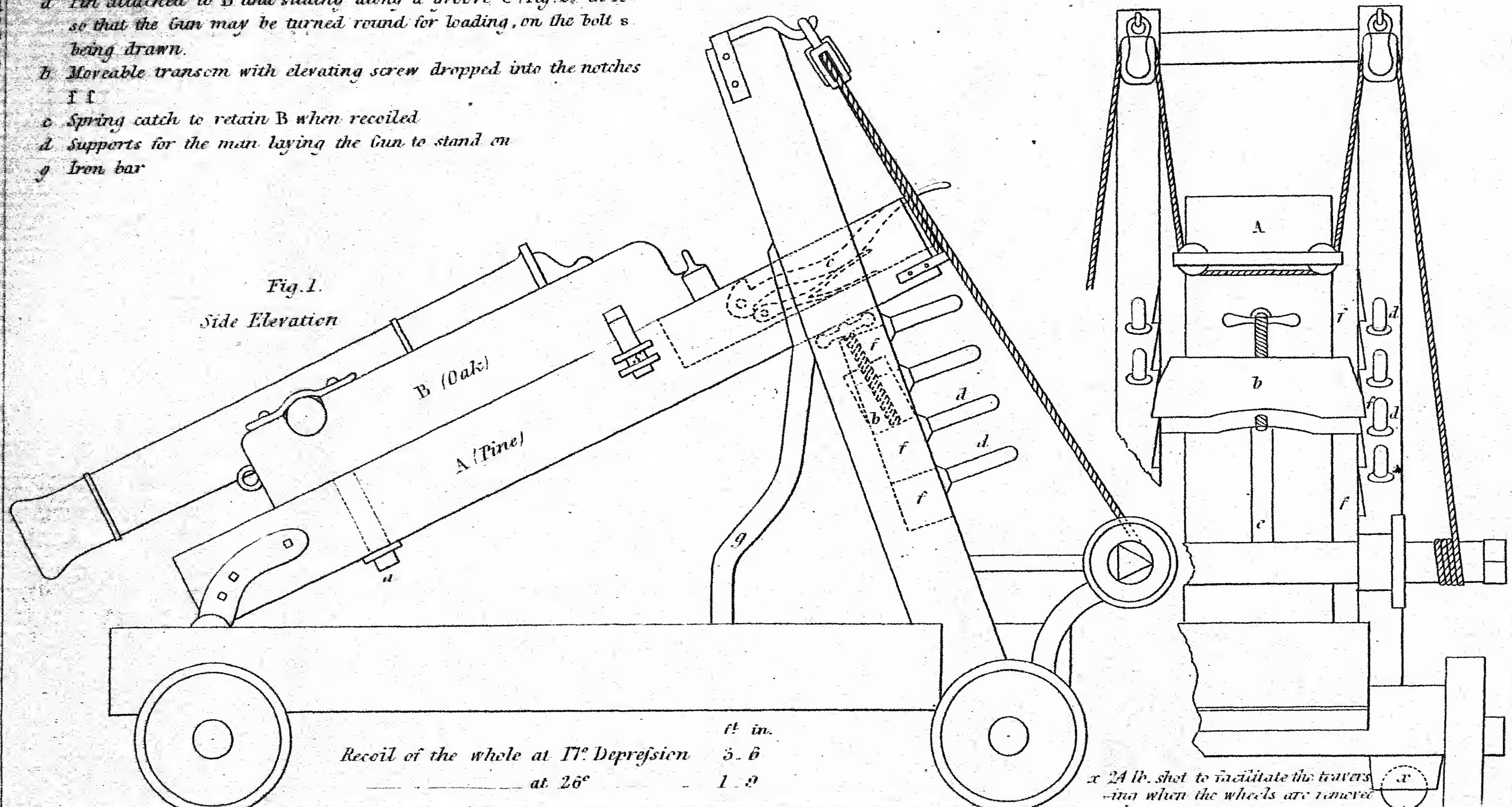


Fig. 1.
Side Elevation

Fig. 2.
Rear Elevation

		ft.	in.
Recoil of the whole at 17° Depression		3 .	6
——	at 26°	1 .	9

x 24 lb. shot to facilitate the travers-ing when the wheels are removed

P. Bainbrigge L^{t} R.E. del.

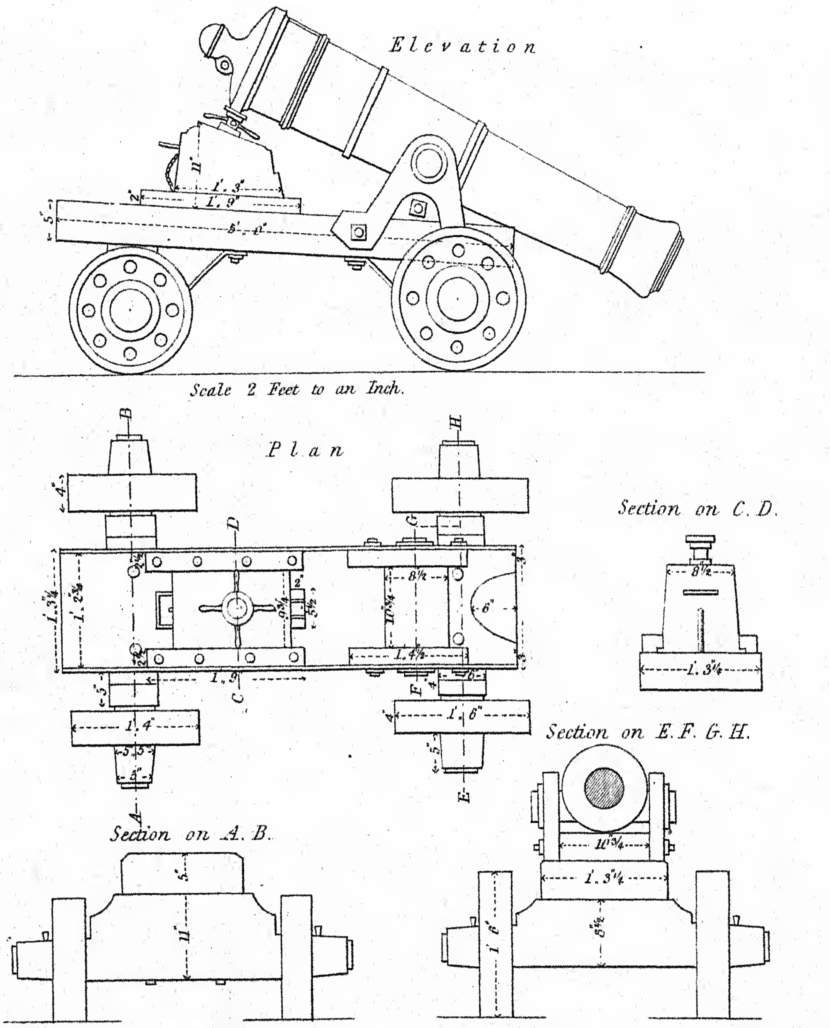
J.W. Lowry fc.

John Weale 59 High Holborn 1846.

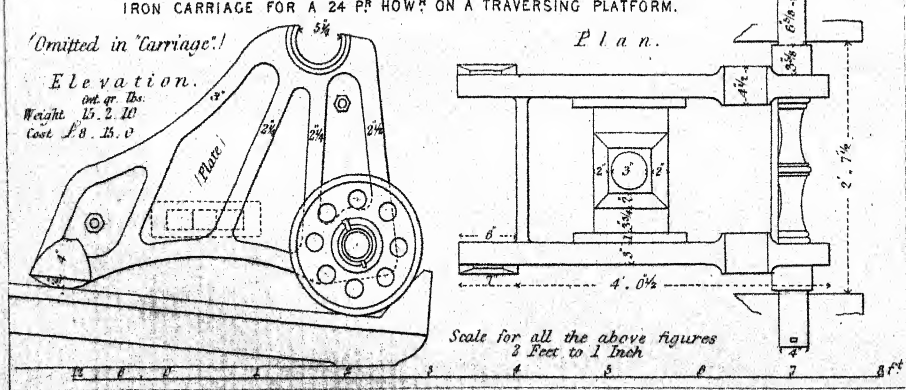
PLAN, ELEVATION AND SECTIONS OF A

DEPRESSION CARRIAGE FOR A LIGHT BRASS 12 Pr. GUN.

LENGTH 5 FEET, CALIBRE 4·62 INCHES, WEIGHT 12 CWT. 0 QRS. 3 LBS.



IRON CARRIAGE FOR A 24 Pr. HOWr. ON A TRAVERSING PLATFORM.



B. Martindale, Lt. R.E. delt.

J. W. Lowry, sc.

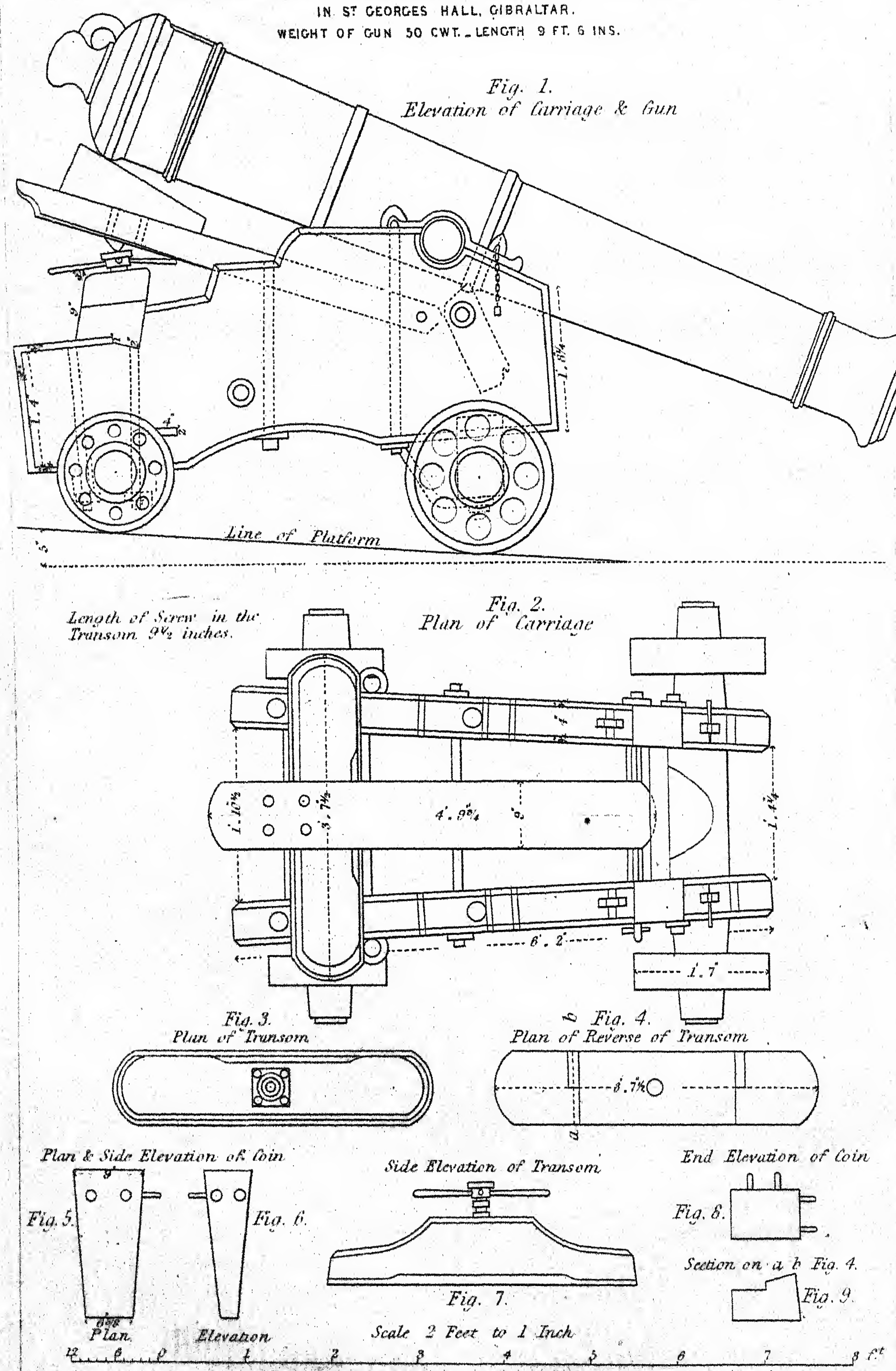
John Weale, 59, High Holborn, 1846.

PLAN AND ELEVATION OF A

DEPRESSION CARRIAGE FOR A 24 P^R IRON GUN

IN ST GEORGES HALL, GIBRALTAR.

WEIGHT OF GUN 50 CWT. _ LENGTH 9 FT. 6 INS.



B. Martindale. L^t R.E. del^t — J.W. Lowry. fc.

John Weale. 59. High Holborn. 1846.

TABLE XVII.

CONTENTS OF A FORGE WAGGON.*

See Plates.

Bellows, pair	1
Anvil, with block	1
Coals, bushels	2

SMITHS' TOOLS IN THE LIMBER.

Tongs, pairs		2
Slice		1
Ladle		1
Vice	Standing	1
	Hand	1
Shoeing Smiths' tools, set		1
Jobbing Smiths' do. do.		1

Small Medicine Chest, for Farriers' use		1
Hammers	Sledge	1
	Hand	1
	Riveting	1
Cold Chisels	Rod	2
	Hand	2
Punches	Rod	2
	Hand	2
Screw-driver		1
Rasps	$\frac{1}{2}$-round	6
	Round	6
	Flat	6
	3-square	6

CARRIAGES, DEPRESSION.

There is a general resemblance only between these and the common standing garrison carriage: for the points of difference, compare them with figs. 6 to 9, 'Carriage,' Plate I. They admit of a depression of 30°, but after every round the piece must be brought to a horizontal position to be loaded, which is done by taking out the rear transom altogether.—(See 'Artillery Tables G. & H.,' pages 66 & 67.)

Elevation, Depression, and Height of an Iron 24-pounder Howitzer mounted on an Iron or Wood Carriage upon an Iron Traversing Platform.

		Elevation.	Depression.	Height.	
		With elevating screw.	With elevating screw.	From platform to axis of howitzer.	Under swell of muzzle at 5° depression above the platform where the trucks stand.
		°	°	ft. in.	ft. in.
Iron 24-pr. howitz. mounted on	an iron carriage	16	5	2 9	2 $2\frac{5}{8}$
	a wood carriage	$17\frac{1}{2}$	5	2 8	2 $1\frac{5}{8}$

CASK.—*See* 'BRIDGE, CASK.'

CASTRAMETATION is the art of laying out Camps, whether the troops intended to occupy them are to be hutted, under canvas, or bivouacked.

Encampments on actual service may be divided into *Camps of Position*, and *Incidental Camps* taken up every night on a march by troops traversing a country where

* From Spearman's 'British Gunner.'

an enemy may be met with. There are also, in time of peace, *Camps of Instruction or Exercise;* but under any circumstances, and whether the troops are hutted, under canvas, or bivouacked, the principles here mentioned should be attended to. Troops are however seldom *hutted*, except in Camps of Position.

The situation selected for a camp should be healthy, not liable to be flooded, well provided with water, and should have abundant supplies of wood and forage close at hand: also, if the troops are on actual service, it must be capable of defence, and should not be overlooked. The British Army generally encamps by brigades, or divisions, independently. The troops of each arm should be encamped in lines parallel to the probable line of battle, and in such a manner that all may form line directly in front of their camp without confusion, by night as well as by day, and act efficiently; the Infantry, if the country is open, being placed so as to be protected by the Cavalry; and, if the country is close, so as to cover the latter, whilst the Artillery should occupy the most commanding positions, (if possible, so as to flank the front of the camp,) and should be duly supported by Infantry and Cavalry.

The flanks of the camp should be, if possible, protected by a village or river, and care should be taken that the prolongation of the lines may fall upon ground whence they cannot be enfiladed, and that the ground in front is favourable for a field of battle.

The camp of each regiment, brigade, or division, should occupy the same space in front which it would cover when drawn up in order of battle, (calculating upon the effectives only,) and there should be ample space in front for manœuvring, and intervals of about 400 yards between the fronts of the first and second lines and reserve, when several corps or divisions are together: the interval between the flanks of battalions, or between those of brigades, may be taken at about a company's length.

The Reserve should be placed so as to protect the approaches to the rear, and also to be capable of quickly affording aid to any of the troops in front.

The communications throughout the camp, across its front, and from every part of it to the front and rear, must be rendered easy,—the lines of retreat being decided upon in the first instance.

Fuel and water are amongst the most necessary items, and their importance will justify the choice of an otherwise inferior position.

The rivulets near the camp should be dammed across at intervals, to retain the water for the supply of the troops, and at as early a period as possible. Where the quantity is limited, an active police must be established, to see that the ponds are not drained for fish;—that cattle have not unrestrained access to it;—that horses are not watered *in* it;—and that the men do not bathe, and that clothes are not washed, in the upper portions. If the river is only to be reached at points under the control of the enemy, they must be either covered or supported by field-works; or the water must be led to reservoirs in the rear, and possibly diverted in its entire course.

A chain of guards must be established round the camp on those points which command the approaches, but not so as to be out of sight; and sentries must be posted, so as not only to prevent the approach of an enemy, but the egress of the troops for the purpose of plundering, &c.

The several Parks should be established about 200 yards in rear of the camp, and remote from houses, so as to lessen the chance of danger from fire: the carriages must be placed so that any of them may be easily moved at any time to the lines of retreat or advance.

The details of laying out Camps for Cavalry, Infantry, and Artillery, are given in figs. 1, 2, 3, respectively. Cavalry rarely encamped during the late war,—but fig. 1 is taken from a Horse-Guards' document, modified to the present circumstances of the

Service. Fig. 2 gives the practice as now established for troops in Ireland: in forming from Line for a Regimental Camp, the battalion being in open column of divisions,—

Grenadiers and Light Infantry stand fast.	No. 2	closes on	No. 1.	The companies of the right wing which move, close to the front; those of the left wing, to the rear.
	4	„	3.	
	5	„	6.	
	7	„	8.	
				Nos. 2, 4, 6, 8, and Light Company, counter-march.

The encampment of the 9-pr. Field Battery allows for 164 horses, as well as for the total number of Gunners and Drivers necessary,—on the Cavalry footing of 12 men per tent.

In figs. 1, 2, no arrangements are made for Sutlers, Bâtmen, and Privies; they may be arranged in the rear, according to circumstances, provided always that they lie within the rear guard.

During the latter part of the Peninsular War, the general issue of tents to the Portuguese troops was discontinued; instead of these their blankets were edged with cord, looped at the corners; and with a squad of four men, these blankets could be thus secured to their muskets, crossed, so as to form a small ridge tent.—(See Table on the next page.)

HUTTING.

For Winter or other Standing Cantonments, when towns or villages are not to be had,—Huts should be made. These have every shape, size, and quality; from the open screen of the Hottentot,*—the roof-shaped Gypsey straw shed,—or the lowest Irish turf sheeling,†—to the cottage built of stone set in clay,—of raw brick,—of cob,—or of 'wattle-and-dab.'

In making cob, straw is trampled into the clay, and the walls carried up in thin courses laid on in small shovelfuls at a time, within two planks on edge as a mould, shifted upwards as the work rises. Less than 12 inches thick of this is musket-proof. In constructing wattle-and-dab houses, there is first a plain frame-work for the walls of upright poles fixed in the ground, and held together above by a wall-plate; the corner and door-posts being stronger than the rest. The poles for the walls may be about 18 inches apart, and are wattled with rods so as to support the clay, which must be worked in by hand on both sides at once,—the first coat being left rough to allow a hold for the second. To give stiffness to the framing, diagonal bracing might be fixed to the walls inside; also across the corners of the wall-plates as dragon-ties. The floor, of well-rammed clay (mixed with cow-dung) and gravel, high enough above the ground to keep it dry. The fire-place and chimney, in all cases, of stone or brick, and best run up in a gable. The thatch of the roof supported on rough slight rafters. The whole whitewashed, inside and out; and a gutter run all round at a little distance outside.

Those who are unacquainted with the virtues of cow-dung will be surprised to find how a clay-floor is improved by being washed daily with a very thin mixture of it and water, which is perfectly inoffensive. Cow-dung also gives great toughness to the clay on the walls: it is for the like reason used in pargeting.

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* Screens of interwoven branches to windward of the bivouac fire: these give great protection from all weather except a downright vertical heavy rain: if they are earthed up for a foot or two above the ground, outside, so much the better.

† Two triangular dry stone wall gables; rough pole rafters resting on the ground, and covered in with sheets of turf: a North-American Indian would use sheets of birch-bark.

Table of Marquees and Tents for the General Service of the Army.

Description of Tent or Marquee.	No. Men for	Extreme space in-side pins.		Weight, lbs. Dry.	Weight, lbs. Wet.	&c. No. Pins. Small.	&c. No. Pins. Large.	&c. Packed in	Tonnage.	Remarks.
		ft. ft.							cub.ft.	
Common circular (or Bell) Tent.	12 Cav. or 15 Inf.	17 diam.	Tent Poles	$56\frac{1}{4}$ $9\frac{1}{4}$	92 11	42	,,	V.	5	It is probable that this weight may be somewhat reduced by-and-bye; the additional weight arises from an improvement in the canvas. Four of these Tents are allowed for each Regiment, as Guard Tents.
			Total	$65\frac{1}{2}$	103					
Marquee, large. Field Officer or Captain: with Ticken lining.	1	35×28	T. P.	140 33	210 34	96	4	V.	12	Not allowed to Cavalry and Infantry of the Line; but they are issued for Artillery purposes occasionally.
				173	244					
Marquee, small. Subaltern: with Ticken lining.	2	31×24	T. P.	117 33	186 34	76	4	V.	11	Do. do. do.
				150	220					
Laboratory Tent. Large, circular.	,,	42 diam.	T. P.	169 83	290 85	96	4	V.	13	For Artillery purposes only.
				252	375					
Laboratory Tent. Small, circular.	,,	39 diam.	T. P.	123 $33\frac{1}{2}$	187 $34\frac{1}{2}$	78	4	V.	$7\frac{1}{2}$	Do. do. Formerly called a Mess-Tent.
				$156\frac{1}{2}$	$221\frac{1}{2}$					
Ridge Tent.	2	8×8	T. P.	20 8	30 $8\frac{1}{4}$	14	,,	B.	$1\frac{1}{2}$	
				28	$38\frac{1}{4}$					
Hospital Marquee.	,,	47×34	T. P.	346 82	560 84	180	4	V.	26	1 per Regiment allowed.
				428	644					

Two mallets allowed for every description of Marquee or Tent. V (in ninth column) signifies packed in a canvas valise: B in a bag.

A great protection against fire may be given by thickly coating the thatch of the roof with whitewash, or rather, very thin mortar.

Without departing from the principle of the length of the front being equal to that of the troops in line,—such an encampment may be so arranged that the huts may support each other by a flanking fire, especially from the Officers' quarters and the Guard-houses.

From the probable scarcity of suitable timber, the huts for the men may be only wide enough for one row of beds: a quarter for fifteen men, at one pace per man, will thus be $37' \, 6'' \times 9'$ in the clear, which, in a cold climate, will require a fire-place at each end. If, however, timber can be obtained, it will be better to make the barracks 20 feet wide, there being no objection to a row of posts down the middle supporting the tie-beams, if necessary.

The following extracts from the Orders of the Light Division, by Major-General Robert Crawford, between 1809 and 1811, and from the Queen's Regulations, are given in reference to the chief points in the routine, and associated duties, of Encampment.—The former are marked by an asterisk.

* As a standing order, when circumstances permit, each regiment will be preceded by two Officers, for the purpose of taking up quarters; one of them will march 24 hours before the regiment, and on his arrival will receive the necessary information from the Assistant Quarter-Master-General, or from the Quarter-Master of the regiment preceding that to which he belongs. The other Officer will march the same day as the regiment does, but sufficiently early to arrive at 10 A.M., when he will have the quarters pointed out to him by the Officer who went on the day before, and who, after having done this, will proceed to the next station.

* The Camp-colour Men, viz. one per company, under the command of the Quarter-Master-Serjeant of each regiment, and one Officer for the column, will assemble at the Assistant Adjutant-General's quarters every morning on the sounding of the first bugle; viz. 1½ hour before the hour appointed for the march of the brigade.

* The Officer in charge of these parties will march them in perfect order, and as expeditiously as possible, to the next station, where he will find the Officer gone forward with the Assistant Quarter-Master-General; and after marking out the quarters of each company, he will take care that each party shall remain together until the regiment arrives.

* The Quarter-Masters will, when practicable, march 2 or 3 hours before the brigade; or, if possible, the preceding evening; and as soon as they arrive, they will proceed to purchase the provisions, forage, &c., for their respective corps.

* When regiments march separately, the Quarter-Master-Serjeants must be sent forward for the above purpose.

* One of the first duties of Officers commanding regiments on arrival in Camp, or Quarters, is to cause the communication from the position or quarters of the regiment to all the principal roads by which the brigade may possibly march, to be thoroughly examined, and all obstacles removed, in order that each regiment, without the assistance of a guide, and without delay, may be able to move in the night, if required, to whatever road in the vicinity of the Camp or Quarters may be pointed out for the assembly of the brigade.

* On entering Camp or Quarters, each regiment must form on the same ground which it is to assemble upon in case of alarm; and when formed, the ranks are to be opened.

* If the companies have to form up in succession, each will slope arms and open

ranks as soon as formed by words of command from its own Officer; but they must not order arms, or stand at ease, until directed to do so by the Commanding Officer of the regiment, which will not be done until the whole corps is formed.

* After the reports are collected as ordered (in a preceding Article), the men may be allowed to sit down, or walk about behind the ground of formation, which will be marked out by a sentry on the right flank of each company; but they must not be allowed to go 10 yards from the spot until the guards and pickets are placed, and all the other necessary arrangements are made; unless it rains hard, in which case the men (except those for duty) may be dismissed as soon as the reports are collected; but no state of weather, nor any other circumstance, is to prevent the corps being kept under arms until the reports of the absentees are regularly collected.

* As soon as the corps are formed, and the reports collected, the guards must be placed, and the men or companies warned for in or out-lying pickets.

On the arrival of a brigade or battalion on the ground destined for its camp, the Quarter, and Rear Guards, of the respective regiments will immediately mount; and when circumstances require them, the advanced pickets will be posted. The grand guards of Cavalry will be formed, and the horses picketed. The men's tents will then be pitched; and until this duty is completed, the Officers are, on no account, to quit their troops or companies, or to employ any soldier for their own accommodation.

The troops must at all times be kept in the most perfect readiness to turn out, and it is expected that in half an hour from the time they receive the order to march, either in the night or day, the army shall stand at the head of its encampment; that the baggage shall be packed, and the whole prepared to move. This state of preparation is equally as essential in Cantonment as in Camp; and in both, the troops must be accustomed to march without any previous notice.

Movements of troops, or dispositions of march, will not always be put in orders, but will be delivered to such persons only as they concern, &c.

On arriving at a camp which is intersected by hedges, ditches, unequal or boggy ground, regiments will immediately make openings of communication 60 feet in width.

The ground in front of an encampment is to be cleared, and every obstacle to the movement of the artillery and troops is to be removed.

Commanding Officers of regiments must take care that their communications with the nearest great routes are open and free from any impediments.

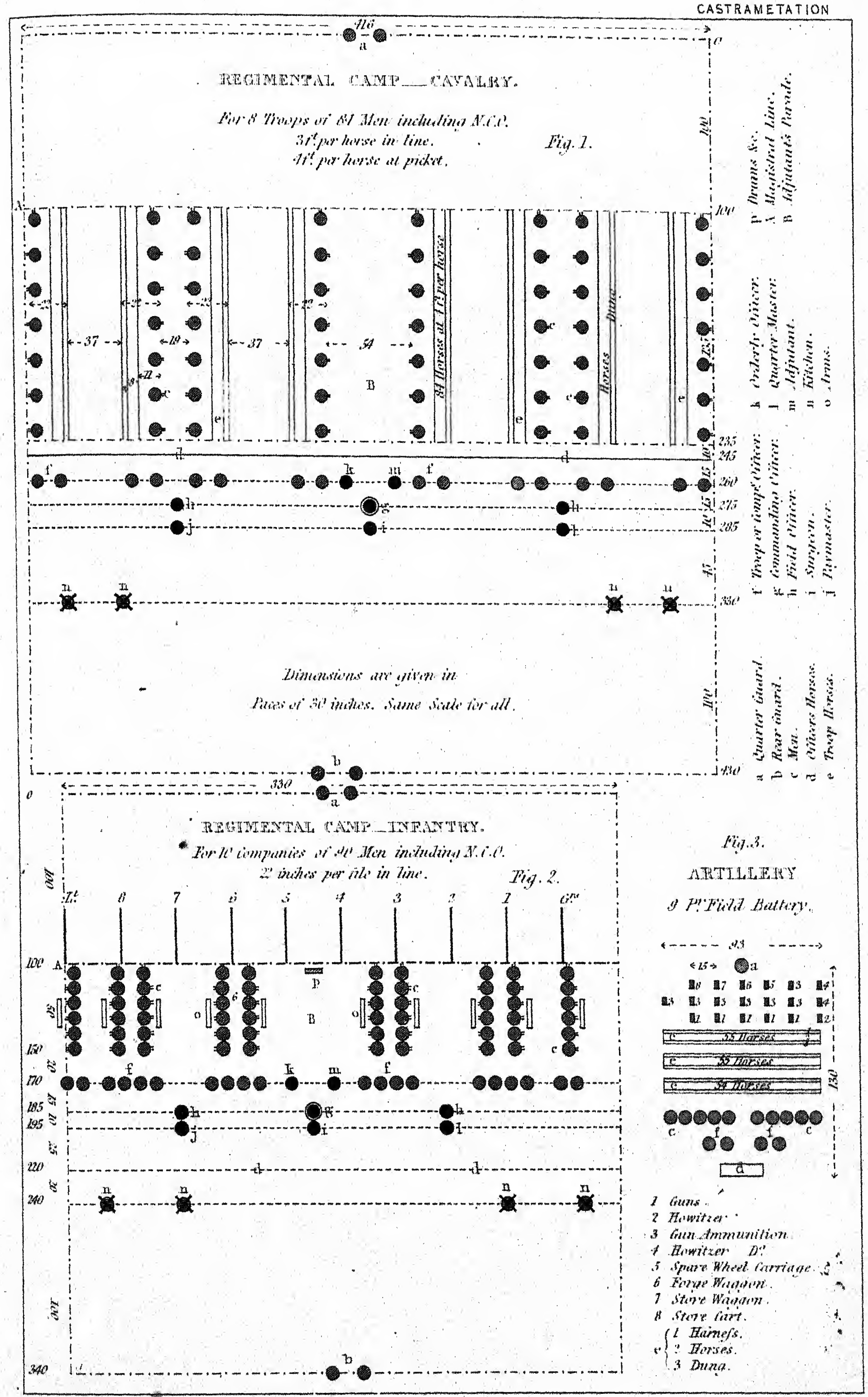
* In camp, the best water will be pointed out before the men are dismissed, and the necessary directions for opening communications given.

* The places for cooking in camp must be pointed out to the Orderly Serjeants of companies by the Captain of the day; and must be particularly chosen, with a view to avoid danger of fire; and for the greater facility of superintending, all the companies must cook as near as possible together.

Whenever a regiment remains more than one night in a camp, regular kitchens are to be constructed.

Necessaries are to be made in the most convenient situations, and the utmost attention is required in this and every other particular to the cleanliness of the camp. If circumstances will allow the ground on which a regiment is to encamp to be previously ascertained, the pioneers should make these and other essential conveniences before the corps arrives at its encampment.

* It must be explained to the men as a Standing Order, that when no regular



J. W. Lowry fc.

John Weale, 59, High Holborn. 1844.

necessaries are made, nor any particular spot pointed out for easing themselves, they are to go to the rear at least 200 yards beyond the sentries of the Rear-Guard: all men disobeying this order must be punished.

It is the duty of the Quarter-Master of the day of the brigade to attend to the cleanliness of the camp, take care that all broken glass, and filth of every kind, are removed, for which the Quarter-Master of each regiment is responsible, as far as the camp of his regiment is concerned.

* If the arms are not piled on the ground of formation, a stake must be fixed, or some other conspicuous mark must be made on the right and left flank of the ground on which each company, when called out, is to form.
* In towns and villages, the Alarm-post will be fixed, and the disposition made for the defence of that portion of the circumference falling within the district of the regiment; and all other necessary directions will be given by Officers commanding regiments, and the distribution of billets made by those commanding companies, before the men are dismissed.
* Officers must always occupy a part of one or more of the houses allotted to their respective companies.

OUTPOSTS.

"As soon as an Officer commanding an outpost or advanced picket (whether of Infantry or Cavalry) arrives on his ground, he must endeavour to make himself master of his situation, by carefully examining not only the space he actually occupies, but the heights within musket-shot; the roads or paths leading to or near the post, ascertaining their breadth and practicability for Cavalry and Artillery, to insure a ready and constant communication with the adjoining posts and videttes,—in the day by signals, in the night by patrols. He should examine the hollow ways that cover the approach of an enemy, and consider all the points from which he is most likely to be attacked. He will by these means be enabled to take measures to prevent surprise; and should he be attacked during the night, from the previous knowledge he has of the ground he will at once form a just estimate of the nature of the attack, and make his arrangements for defence with promptitude and decision.

"An intelligent Officer upon an outpost, even unprovided with intrenching tools, will materially strengthen his post, when the unobserver would remain inactive. A tree felled with judgment, brushwood cut to a certain height, pointed stakes about breast high placed on the point most assailable to an enemy, may be attended with the greatest advantages, and can be effected with the common hatchets or bill-hooks with which the soldiers are provided for the purpose of cutting fire-wood.

"Nothing checks the ardour of troops more than an unexpected obstacle within point-blank musket-shot of the place attacked: this must not be overlooked by an Officer who defends; and no obstacle he can throw in the enemy's way at that distance from his post must be deemed unworthy of his attention.

"At night, or in thick weather, the videttes, or sentinels, on outposts are to be doubled." R. J. N.

CHAIN.—*See* 'CABLE, CHAIN.'

CHEVAUX-DE-FRIZE.

Ordinary pattern, of wood,—square barrel.

Barrel.—Length,	9′ 6″.	Breadth and Depth, $3\frac{1}{2}$″.	Weight,	35 lbs.
Spears (20) „	6′ 0″.	Diameter of Bundle, $7\frac{1}{2}$″.	„	61 „
		Total . . .		96 „

Each spear is $1\frac{1}{4}$″ diameter, with a plain square iron point, and a stud in the middle of the length to lock inside the barrel-plate.

The barrel is secured at each end by an iron band, 3″ broad × $\frac{1}{8}$″ thick, through which the outer spear passes, and to which the T & O keying-chains are fixed. Each spear-hole is guarded by an iron plate (on one side of the barrel only) $3\frac{1}{2}$″ × 3″ × $\frac{1}{8}$″, with a notch in the edge of the circular hole to allow the spear-stud to pass and lock. The spears are made of ash, and the barrel of Memel fir.

New pattern, of iron,—cylindrical barrel; the whole consisting of tubes, the spears (twelve in number) being plugged at the ends with points; and packing away inside the barrel.

Barrel.—Length,	6′ 0″.	Diameter, exterior, $4\frac{3}{4}$″. / „ interior, $3\frac{5}{8}$″.	Weight,	22 lbs.
Spears (12) „	4′ $7\frac{1}{2}$″.	Diameter of each, $\frac{7}{8}$″	„	43 „
		Total . . .		65 „

The wooden pattern has the advantage of being somewhat lighter, the length of 9′ 6″ in both being 96 and 103 lbs., wood and iron respectively. It is more easily replaced and repaired, and the length of 9′ 6″ renders it more available as a barrier or temporary gate for closing openings through which carriages are to pass, than the 6′ of the iron pattern; which last has the advantage of great portability in reference to bulk. R. J. N.

COMBUSTION, SPONTANEOUS.

Few or no chemical combinations can take place without a disturbance in the equilibrium of caloric in the substances to be so combined; and when caloric is thereby evolved in sufficient extent and rapidity, and when one or all the bodies engaged may be freely combustible, ignition takes place. When this is unintentional, or is the result of ignorance or carelessness, it is convenient to call it *Spontaneous* Combustion.

Thus we frequently hear of hay-ricks, &c., on fire; or occasionally of carts loaded with quick-lime being burned by the rain falling upon it. There are also somewhat apocryphal accounts of coal in coal-yards being destroyed in like manner. But the most important instance of this class, as far as regards the preservation of Government establishments, is the combustion that infallibly and rapidly ensues when greasy hemp, flax, or cotton, is allowed to remain loosely heaped together, in any quantity, in a confined unventilated space.

Full proof of this has been made by experiment in the Dockyards; and there is much reason to attribute many fires in former days to carelessness in the rope-walks and hemp stores: in consequence of which, rigorous orders were subsequently issued as to the immediate disposal of loose oakum and hemp sweepings—all more or less greased or oiled. The very oil-rags used by engravers in cleaning plates, when heaped together to any amount, will be consumed in a few hours.

The combination in question seems to be between the oil and the oxygen of the atmosphere. Oil has always an affinity for oxygen; though, when the bulk of the former is considerable in proportion to the surface, the action is but feeble, and the results not ordinarily appreciable: but in the case of admixture of such fibrous vegetable bodies as hemp, flax, or cotton with oily matters, where the ratio of surface to solidity is great, and when the conditions for accumulating heat are favourable,*—this accumulation soon produces ignition amongst such inflammable bodies as those just enumerated. R. J. N.

COMMAND.†

"Every one must have observed, that there exists amongst all classes of men a sort of vague and general impression, that missiles, projected from elevated situations, have a more destructive and more irresistible effect than when projected from an equal level; yet no one can doubt that artillery, firing from an elevated situation, is less destructive to bodies of troops than when firing on the same level, in consequence of its great plunge, which scarcely admits of one shot killing more than a file or two; whereas a horizontal discharge frequently sweeps or bounds through a whole column.

"With respect, however, to the effect of artillery firing from a height on a besieger's approaches, there is little accordance of opinion even amongst professional men, and probably for this reason, that it is almost entirely dependent on distance.

"Thus, for instance, a battery of 24-pounders, placed on an elevation of 100 or 120 feet, though firing down on a trench at the distance of 700 or 800 yards, requires an elevation of 1 or 1¼ degree above its crest to reach it; and the same guns firing at a trench on an equal level at the same distance, require scarcely more elevation above it; so that the difference of the curve formed by the shot, at the instant of striking the trench from either situation, is almost imperceptible; and the force of the shot being in both cases the same, no other cause can be assigned why the action of the one should be more destructive than that of the other.

"It is, however, very different with the same guns when firing from a similar height, of 100 or 120 feet, at a battery or trench only 300, 400, or 500 yards distant; as the guns being then fired directly down on the work, the shot frequently strikes near the interior edge of the parapet with its greatest force, and passing through 4 or 5 feet of the interior revetment, renders every part of the battery insecure.

"The deduction is, that guns firing from a height on a besieger's approaches, unless the height be within 400 or 500 yards, are less destructive than similar guns firing à ricochet on an equal level.

"Height of situation invariably gives a more destructive effect to musketry on the approaches, as its use implies close approximation, in which case it is nearly impossible to raise the parapet of a trench or sap sufficiently to cover more than a very small breadth of its surface.

"In the attack of a mountain fortress, the effect of a direct fire does not seem to be materially diminished by the height of the defences.

"Height of situation is even likely to offer a facility for reducing small posts by means of the Miner.

"Works on heights, however, when properly constructed, have the excellent defen-

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* Flax, &c., and the air amongst the loose fibres, are both imperfect conductors of heat; also, the space being assumed to be confined, there are no passing currents of air to reduce the temperature.

† Abridged from 'Sieges in Spain,' by Major-General Sir J. T. Jones, R. E. Second edition.

sive property of more effectually covering their scarps, palisades, and defenders, than works on a plain; and, when the rise of the height is very rapid, it utterly precludes the formation and use of batteries à ricochet; besides which, their glacis necessarily terminating in a very sharp angle at its crest, occasions an enormous labour to the besiegers to form a sufficient base on which to place their breaching batteries.

"It should, however, be mentioned, as some counterbalance to these advantages, that a height of one continuous and rapid ascent gives a facility to a besieger for pushing forward his approaches, because, on an inclined plane, less height of parapet gives cover in the Sap than when formed on an horizontal base; and the guns of works on steep heights can seldom be sufficiently depressed to fire on the trenches, and the progress of the Sap can only be opposed by musketry or vertical discharges.

"To carry approaches from a height against a work situated on a parallel height, having a valley between them, is attended with considerable difficulties; for, if the side of the hill to be descended be very steep, no practical depth of trench or height of parapet will give cover to the troops, unless each return of the approaches be directed very much clear of the salients of the work under attack, which increases considerably the length of each return, and consequently the labour of forming it; and, even after this additional labour, the ordnance next the salients of the besieged place, which take the approach en écharp, have a murderous effect.

"The depth required to obtain cover will, of course, be greater or less in descending equal slopes, according to the relative height of the ground to be opened for the approach and of the enemy's work.

"Another inconvenience, incident to carrying approaches down very deep declivities, is that the rear of the trench is higher than the parapet in front, and many howitzer shells, fired à ricochet, which miss the former, are stopped by the latter, and fall into the trench; and frequently, shells from mortars, pitched beyond the trench, roll back into it, in consequence of the steepness of the face of the hill.

"It is apparent that as the approaches nearly reach the bottom of the valley, these evils increase, and that all the advantages of defence to be drawn from height of situation operate against the besieger's trenches in a ratio according to the steepness of the descent and the relative height of the sides of the valley; therefore any plan of operations, which necessitates carrying the approaches across a valley for the attack of a work on the opposite side, should, if possible, be avoided.

"From these various counterbalancing properties, resulting from height of situation, it may be concluded, that a fortress is not to be pronounced of great strength from the circumstance of elevated situation alone; for, even to form a moderately just opinion of its strength, it must be ascertained that its walls are all covered from distant batteries, that its interior be casemated, that the face of the height be under fire of the ramparts, or, if precipitous, that it be flanked on every point. If such, however, be found the case, height of situation must be considered to add greatly to the defensive powers of a place, and demands our respect.

CONSIDERATIONS ON THE DISADVANTAGES ACCRUING TO A PLACE FROM BEING COMMANDED.

"Having endeavoured to discuss the real value of height of situation as a defensive quality, it may not be amiss to endeavour to ascertain the amount of the ill arising from its reverse, or a place being situated lower than the hills without it; and to inquire if it really be an evil of such magnitude as is generally supposed—the term 'commanded' being usually accepted as denoting everything bad; and many Officers even carrying their feeling on this point so far as to believe that a very commanding height deprives a fortress of all powers of resistance.

"The most prominent disadvantages under which a fortress labours from being commanded are, that the defenders of the work, and the interior of the place, are seen and exposed to the direct fire of a besieger's artillery; that its escarps are also exposed to be battered in a certain degree lower down, according to the greater or less height of the hill which commands them; and that in the same degree, the range of the enemy's projectiles is increased.

"Considered abstractedly, to be seen is rather an inconvenience than a positive ill; and as projectiles are never used at sieges from situations requiring their utmost range, the prominent evils from being commanded reduce themselves to two,—the greater exposure of the escarps, and the direct fire of a besieger's artillery on the garrison, whilst defending the works, and on the works themselves and their armament. Now the point-blank range of a 24-pounder being under 600 yards, and as it will not batter with good effect at a greater distance than 800 or 1000 yards, it would seem that all command in front beyond the latter distance is nearly harmless, except from the inconvenience it occasions to the garrison of being seen.

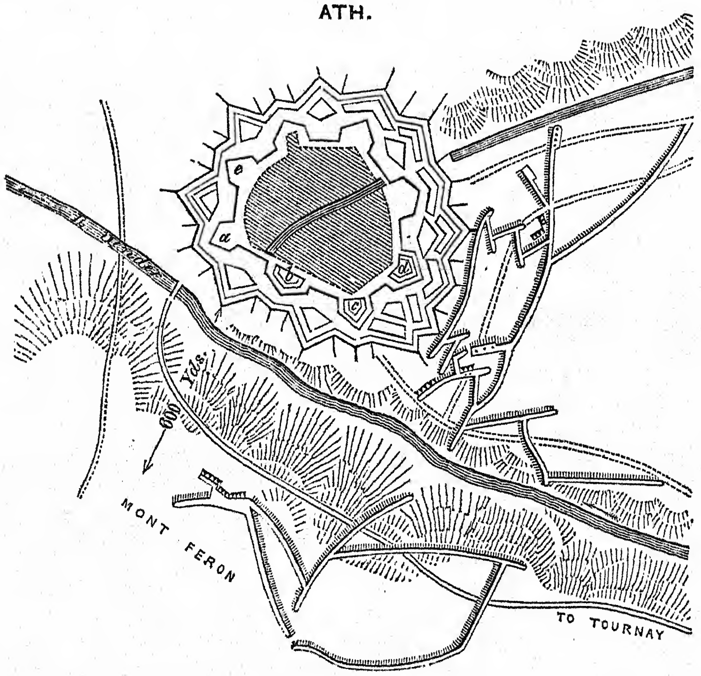
"Within the distance of 800 yards, being commanded, is, indisputably, a most serious detriment to a place, as its artillery may be dismounted, its defenders killed, its escarps laid open, and its buildings destroyed by a direct and accurate fire from the height; but the effects of such command may be greatly reduced, or even rendered null, by a just disposition of the works, and their relief. If a place be only commanded by one hill, and that of a moderate height, it requires no stretch of the imagination to comprehend, that if, instead of being built on a horizontal plane, as is customary, the works were constructed on a plane passing from some point in the interior, a few feet over the top of the hill commanding them, they would equally cover each other, and their parapets equally cover the defenders, as if the hill did not exist, and they had been built on a horizontal plane. Upon a similar principle, the exposure arising from the direct command of several moderate hills on the same front may be avoided; and even the works may be screened by the above method, and by the addition of traverses, parados, &c., from the command of such hills all around the place.

"But if the hills are of a great height, and near the place, the mischief arising from their command cannot be obviated by defilement; and even in many cases where it is possible to effect this defilement, the great labour and expense of so doing put it out of the question. Under such circumstances, the best resources are casemates and countermines, or to occupy the summits of the commanding hills by works of sufficient strength to restore the equilibrium of defence.

"There remains a disadvantage still to be mentioned, accruing to a place from being commanded, which is, that a besieger's first batteries, placed on the height which commands it, may remain open till the last moment of the attack without incommoding his near approaches; but when the height falls rapidly in one continued plane to the glacis of the place, this advantage is much counterbalanced by the difficulty mentioned before, of carrying the approaches down hill; and should the fall of the ground be gradual, it will frequently happen that the fire of the batteries on the height will prove almost as annoying to those in the advanced part of the trenches as to the defenders of the place.

"From these causes, command is far more prejudicial to the defence of those works of a place, the general prolongation of which it intersects, than to the defence of those works to which it is parallel; even if the distance of the lateral command of such height be greater than that of its direct command. This may be exemplified by reference to the attacks of Ath, in 1697 and 1700, by those great masters of the art, Vauban and Marlborough, and subsequently by the Count de Clermont in 1745.

ATH.



"Two fronts of the enceinte of that fortress, *a*, *b*, *b*, *c*, are traced parallel to Mont Feron, which, at 600 yards distance, overtops their ramparts 75 feet, the interval being a regular slope to the foot of their scarps, and which no exertion of art has been able to screen from the direct fire of artillery from so domineering a point in their immediate front. Still, in neither attack, did those Officers avail themselves of batteries on this commanding height to breach the scarp walls of the fronts opposed to it, or for establishing a commanding fire to ruin their parapets, and then carry their approaches almost unopposed down the face of the hill to the counterscarp; but, on the contrary, establishing on the height powerful enfilading batteries to ricochet the collateral fronts, the prolongation of which the command of Mont Feron intersects, Vauban carried his approaches towards the front *a*, *e*, to the right, and Marlborough his towards *c*, *d*, to the left; and to each, Ath fell an easy conquest.

"The Count de Clermont, in 1745, followed with equal success the path traced by the British General; so that it may safely be inferred from these examples, that the side of a place most closely commanded, when that command is direct, is not consequently the weakest.

"From the above statement it is apparent, that a fortress is not to be lightly and utterly condemned because it may happen to be commanded; for if the heights commanding it be at a greater distance than 800 or 1000 yards, and do not enfilade any general line, they can have very little influence on the attack or defence. If the heights are not more distant than 600 yards, and on one side only, the effects of their command may have been parried by defilement; and by the same art, a certain degree of strength may have been given to a fortification when closely surrounded by moderate heights; and even where defilement has been impracticable, casemates, countermines, reverse batteries, and retrenchments, on the weakest fronts,

may have more than compensated the general exposure. But if on examination these precautions are found to have been neglected, a fortress which is closely commanded by heights may safely be pronounced of little strength,—though there are innumerable instances in former, and some few in late wars, of such places having made good defences, from the intelligence of the Governor reserving the troops for the last stages of the defence, when the combatants become too closely in contact to admit of the interference of fire from distant batteries."

For *Relative* Command of Works, see 'Relief' in the Construction of Permanent and Field-works.

COMPASS, HARRIS'S MAGNETO-ELECTRIC.—The inventor's object, in the application of his discovery of the steadying action of the copper ring, "is the combination of great sensitiveness with stability and simplicity of construction; so that whilst the needle is free to obey the magnetic force of the earth in the most perfect way, it yet remains tranquil amidst the disturbing motions to which a ship is exposed: and this stability is obtained without the aid of friction or other mechanical impediment, which often produce an apparent steadiness, or rather sluggishness of the compass (arising from indifference to motion), at the expense of accuracy.

"When the horizontal position of the card is disturbed by any alteration of dip incidental to a change of latitude, it is to be corrected by moving the silver sliders on the needle.

"Should the compass be out of use, care must be taken to let the needle hang freely in the meridian; and if put into a store-room, or otherwise set by, the card and needle should be removed altogether, and placed with the needle downward in the shallow box provided for it,—the north point being on that part of the keeper marked with a cross, thus ×. A good compass is liable to deterioration and damage when stowed away without regard to its magnetic properties, and without due care being taken to preserve the agate and the point of suspension in a perfect state."

On the writer's own observation of this compass, the needle was at rest in exactly one minute: it is stated to have been so in 45 seconds at other times. R. J. N.

CONTOURING.*—This term is applied to the outline of any figure, and consequently to that of any section of a solid body; but when used professionally in connection with the forms of ground, or of works of defence, the outline of a horizontal section of the ground, or works, is alone to be understood by it.

When the forms of ground or works are described by contours, or horizontal sections, these sections are taken at some fixed vertical interval from each other, suited to the scale of the drawing, or to the subject in hand; and the distance of each, above or below some assumed plane of comparison, is given in figures at the most convenient places on the plan. When the scale of the drawing is about 100 feet to an inch, 2 or 3 feet will be found a convenient vertical interval between the contours; and however large the scale of the plan, it will scarcely be found necessary to obtain contours with a less vertical interval than 2 feet. If the scale of the plan be about 250 feet to an inch, or the ordinary special survey scale of 4 chains to an inch, 5 feet will prove a convenient vertical interval; and with a horizontal scale of from 500 to 800 feet per inch, 10 feet may be taken as the vertical interval. The French generally employ an imaginary plane of comparison above the highest points in the plan; but there does not appear

* By Captain Harness, R. E.

to be any good reason why the figures, which would denote the altitudes of the several points of a plan above the level with which they are usually and naturally compared, should not be employed to denote the levels of the contours. Near the coast, the level of low water, the plane of comparison for the soundings in nautical charts, is the natural plane of comparison for contours; and the numbers affixed to them, when this is adopted, express their altitudes in the ordinary way.

Contours not only furnish a correct idea of the reliefs of the ground, &c. represented, but many problems can be worked by them without the aid of vertical sections: the following are the most useful:

The scale of a plane passing through three given points, A, B, C, (fig. 1,) *may be found* by so dividing the line A C, joining the highest and lowest of the given points, that the two parts may bear the same proportion to each other as the numbers expressing the difference of level between the third point and each of the other two; *i. e.* making $AD : DC :: A \backsim B : B \backsim C$; D will be on the same level as B, and B D will be a horizontal of the plane required.

To find the scale of a plane passing through two given points, and having a given inclination.—The inclination determines the interval in plan between the contours passing through the two given points. With one of the points as a centre, and that interval as a radius, describe a circle; the tangent drawn to the circle from the other point is a horizontal of the plane required. If the distance between the points is less than the necessary interval between the contours, this problem is impossible: when possible, it always admits of two solutions.

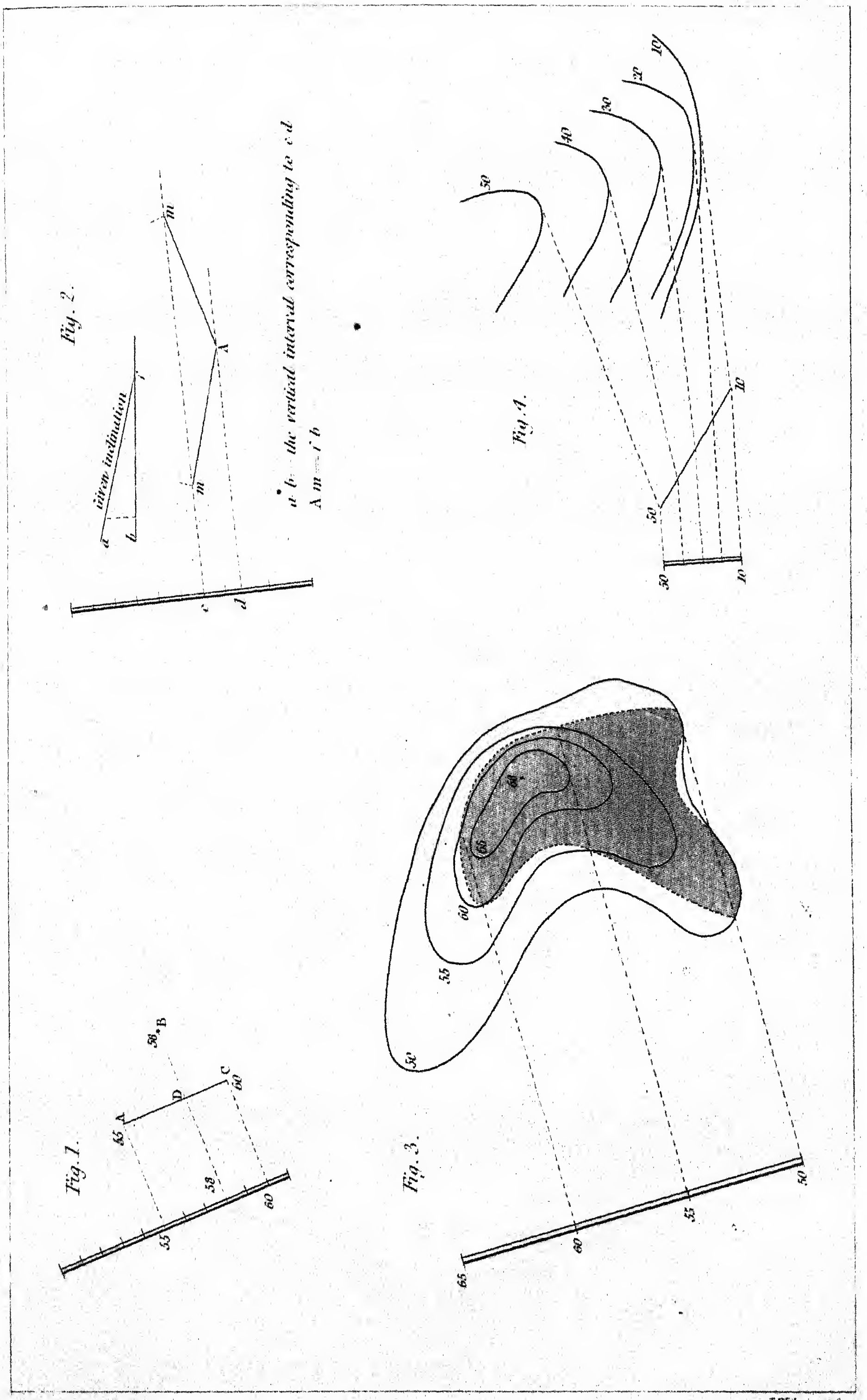
To find the scale of a plane passing through a given point, and parallel to a given plane.—It will agree in direction, and in its divisions, with that of the given plane; the numbers need only be varied to correspond with the level of the given point.

To find in a plane, given by its scale of slope, as in fig. 2, *a line passing through a given point,* A, *and having a given inclination less than that of the plane.*—Trace a contour of the plane having any convenient difference of level from the given point; with that point as a centre, and with the base due with the required inclination of the line to the assumed difference of level as a radius, describe an arc cutting that contour; a line drawn through either of the intersections and the given point will have the required inclination.

To find the intersection of two planes.—Produce, until they meet, two or more contours, having corresponding levels of each; the line joining the points of meeting will be that of intersection. If the contours of the two planes be parallel, their intersection will be known if one point in it be found; assume a third plane; mark its intersection with each of the others; the meeting of the two lines of intersection will be the point sought.

The intersection of the horizontals of any plane with the contours of a given surface at corresponding levels, shews, as in fig. 3, *what part of such surface rises above that plane.*

To find the plane passing through a given line and tangential to a given surface.—When the line is inclined, mark (producing it if necessary) the points having the same level as the contours of the given surface, as in fig. 4, and draw from each of these points a tangent to the contour on the same level with it; the tangent which forms the smallest angle with the lower part of the given line will be a horizontal of the plane. If the given line be horizontal, draw a tangent parallel to it to each contour of the given surface; trace through any point in the given line, as in fig. 5, a line cutting the tangents drawn to the contours of the surface; set off upon the given line, beginning from the same point, distances proportioned to the several differences of level between the line and each contour (when the vertical interval is constant, this



J. W. Lowry fc.

John Weale, 59, High Holborn, 1845.

Fig. 5.

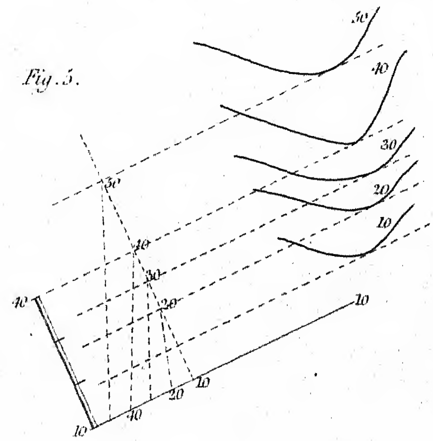
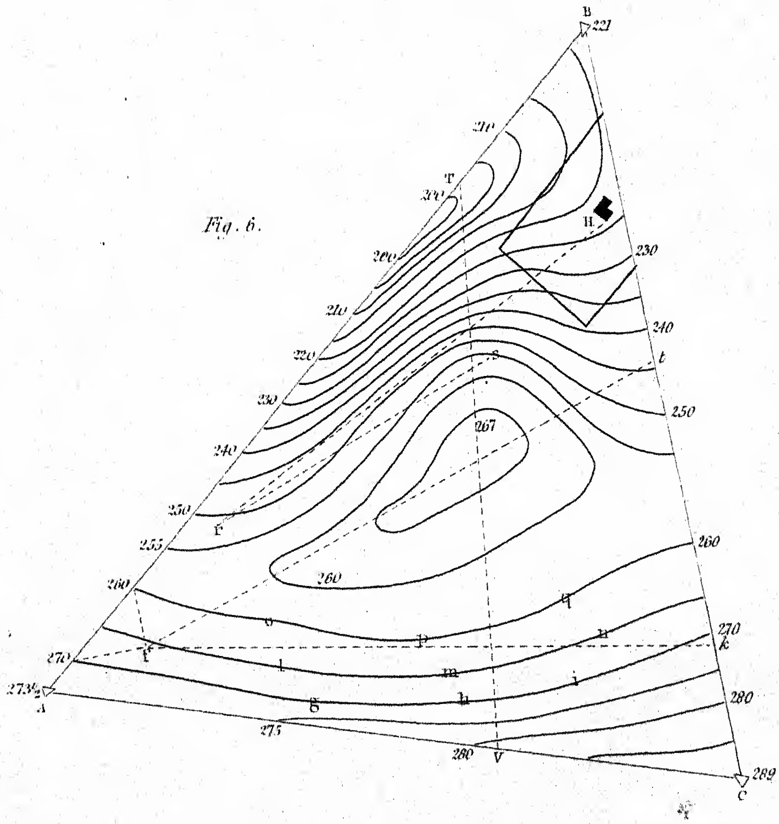


Fig. 6.



J.W. Lowry fc.

John Weale, 59, High Holborn, 1845.

D.

DAM, PERMANENT.—*See* 'River Navigation.'

DAM, TEMPORARY.*

Dam,—a bank or obstruction built across a river or stream, for the purpose of raising the level of the water on the upper side of it.

Application.

There are many objects for the attainment of which it may be necessary thus to check the course of a stream, and gain a head of water: it may be requisite to turn it for a time into another channel; to inundate the ground in front of part of a military position; to make a portion of the stream unfordable; to secure depth sufficient to enable vessels of a given draught of water to navigate the stream; or to gain a power to be applied to mechanical purposes. The works for the attainment of the first three of these objects belong more particularly to the class which Officers may be called upon to execute in the course of a campaign; and the details here given refer entirely to works composed of such materials as may be expected to be within reach of an Officer on service.

Dams built for the purpose of inland navigation, or for that of securing a water-power, may be considered as having a more permanent character, and will be treated of in the article on 'River Navigation.'

Choice of Site.

The first consideration in forming a dam across a stream is the choice of a proper site: this must of course be decided with reference to the objects to be attained by the rise of water, but there are a few general rules to which attention should be paid.

In streams liable to sudden floods it would be advisable to carry the dam across the widest part of the stream, so as to allow ample space for the water to flow over, and thus to prevent any sudden and great rise above the dam; or it may even be advisable to carry the dam in an oblique line across the stream.

In rivers where much drift timber is likely to be brought down, the dam should be situated below a bend in the stream where an eddy is formed, by means of which the collection and removal of the timber will be facilitated.

The banks of the river or stream should be carefully examined with reference to the quality of the soil of which they are composed, and their power of acting as abutments to the dam.

When the site of the dam has been decided upon with reference to the principal objects which it is intended to answer, the necessary levels must be taken, and the height of the structure determined: upon this will depend in a great measure (when materials are plentiful) the plan to be adopted in forming the dam.

Construction in rocky sites. Plate I.

In shallow rivers, when the bottom is rock, a dam of the section shewn in fig. 1 may be easily constructed, of 10 or 12 feet in height. The sill (*a b*) is bolted down to the rock with fox-wedge bolts. The standard (*b c*) is mortised into this sill, and a brace (*a c*) is framed into the two, making thus a strong vertical frame. When the dam is high, a second brace may be inserted, and the horizontal distances between the frames diminished; but in general, 8 or 10 feet may be allowed as a fair distance between these frames from centre to centre. When the frames are securely fixed, a facing of logs, roughly squared on the upper and under sides, is laid in front of them, across the bed of the stream. These should be got as long as possible, and

* Chiefly by Capt. Sir Wm. Denison, R. E., embodying some fragments by Capt. Bainbrigge, R. E.

should break joint occasionally against a standard to which they should be sometimes pinned with a trenail, in order to prevent their moving.

When the water is intended to flow over this dam, the space between the frames in rear should be filled in with blocks of rough stone, well wedged together and laid in steps, so as to break the fall of water on the bed of the river in rear. If material of the proper quality cannot be found, or if the time will not allow of its being quarried and placed properly, this space may be filled in with earth and rubble, and logs being notched down upon the back braces of the frame, stout planking should be spiked over these logs, so as to present a smooth surface for the waste water to flow over, and to act as a protection to the stones, earth, &c. below. The front of the dam should also be filled in with earth, rubbish, &c.; and if the surface of the rock is so uneven as to prevent the front logs bearing fairly upon it, brushwood and fascines may be placed in front, so as in some measure to close the spaces between the rock and the logs.*

Construction when the ground is soft.

When the bed of the river is composed of sand, clay, or material too soft to resist for any length of time the action of the water, the plan shewn in fig. 2 may be advantageously adopted. This frame is composed of a sill, extending not only the width of the dam but also of the apron in rear, notched down and pinned to three or more sleepers, which are laid transversely to the stream, and sunk into the bed of the river. Into this sill the beam (*a b*) is framed at an angle of about 30° with the horizon, and supported in this position by the two struts (*b c*) (*d e*) at an angle of about 60°. These frames are placed at about 8 feet apart, and upon them are notched the horizontal beams which carry the planking with which both the up and down-stream sides of the dam are covered.

In order to prevent the water making its way under the dam, a row of plank piling (*d*) about 5 feet long and 4 inches thick should be driven in front of the upper sleeper, and a line of waling (*f*) upon this row of piling should be well spiked through the piles into the frame. In order to secure the work more completely against leakage, clay should be thrown in front of the sheet piling to a height of 1 or 2 feet. An apron (A), as shewn in figs. 2, 3, is a necessary addition to every dam constructed across a river when the bed has not sufficient tenacity to resist the action of the water. This may be composed of logs notched upon the sill-pieces and covered with plank, or of rough logs, notched and pinned down upon the sleepers in close contact with each other: it should extend far enough below the dam to conduct the water away safely, and should have a row of sheet piling in rear, as shewn in fig. 3.

Construction when timber is plentiful.

When rough timber is plentiful, a dam, as shewn in figs. 3 and 4, may be easily and quickly constructed thus: two or three rows of rough sleepers are bedded across the stream, and upon these rough logs are notched and pinned at intervals of about 5 feet in the rear of the dam. Over one of these sleepers another transverse log is notched upon the first row of longitudinal timbers; and if the dam is a large one, perhaps a second transverse timber may be required. The second row of longitudinal timbers is notched upon the second row of transverse timbers, not exactly over the first row, but just so much clear of it as to allow of the end being notched and pinned upon the ground-way or sleeper at the upper side of the dam, close alongside of the first timber. Row after row of timber is thus placed, the dam constantly rising in rear by the thickness of a log for each course, while in front, all

* Occasionally, however, when the strata cross the bed, and particularly when they crop-out against the stream, great additional stability may be obtained by abutting the lower parts of the dam against the basset edges of the rock.—*Editors.*

are brought down and pinned to the ground-way. When the necessary height is obtained, the top row of longitudinal timber may be laid side by side in as close contact as possible, and the spaces made good with small fascines, bark, &c.; or rows of transverse logs may be placed at about 3 feet apart, and planks spiked to them. The rear of the dam appears as shewn in the sketch, figs. 3 and 4, of alternate rows of longitudinal and transverse timber, to which planking is spiked.

When timber is plentiful and the river is deep, a dam may be safely constructed to a great height of crib-work, that is, of a series of rough cases formed of whole timbers notched together at the crossings, as shewn in fig. 5. In framing a dam of this description, two logs are laid in a direction transverse to the stream, at the same distance apart as is intended for the width of the dam: upon these cross logs are notched at distances of 6 or 8 feet; other transverse timbers are notched upon these, and the dam is carried up in this way until it arrives at its intended height. Sometimes it may be advisable to divide the interior space into smaller compartments, by introducing more transverse timbers: during this, very little impediment has been offered to the stream, which flows through the interval between the logs.* When the crib-work is complete, the spaces between the cribs are filled with stone, if it can be procured; or if not, with fascines, earth, &c., and a mass of earth and rubbish is thrown into the river in front of the dam, so that by degrees a mass is accumulated sufficient to prevent leakage. This work is carried on simultaneously from both banks; and as the water-way is checked, so the stream rises above the dam, rushing through the central space left for its passage. The same process may be continued till the dam is completely closed; but as large quantities of earth, &c. would be washed away in attempting to close the opening between the logs in this centre bay, the best plan is to prepare a frame to receive a sort of gate made of logs, which can be dropped down from above, and which will close the opening sufficiently to prevent much waste of material taking place.†

Construction when timber is scarce.

When timber is scarce, fascines and hurdles may be used in the construction of dams. In Holland and Germany they are very commonly employed for this purpose. A course of large fascines is first laid, the length of the fascines being in the direction of the current, and each in as close contact as possible with its neighbours: upon this a second course is laid transversely, strong pickets are driven through these two courses to connect them together, and the heads of these pickets are wattled together, so as to make a kind of hurdle-work, which serves to connect the whole more completely into one mass: these layers of fascines are then continued in the same manner, each course being picketed to those below, and the pickets connected at top with hurdle-work until the dam has attained the proper height. Very large rivers with a great depth of water have been successfully dammed up and their courses changed by works constructed in this manner. Where the water is deep, gabions loaded with stones, square wicker-baskets filled with stone, &c. have been used to form the foundation of the dam; and upon this a superstructure, as before described, has been raised.

The above are a few of the most simple and of the readiest modes of constructing dams; modifications may, of course, be made to any extent: two or more of these

* In executing this sort of work, the first logs float on the water, and are gradually sunk by the increasing superstructure.

† Experience has likewise shewn that when the water is deep and even rapid, the front of the dam may in like manner be formed of portions of crib-work, two bays in length, constructed ashore, dropped down into position and arranged on the arc of a circle, in plan; beginning from each flank, filling them as soon as properly placed. This, as the body of the dam, must be assisted and supported by slopes of clay, &c., as in figs. 1, 2.—*Ed.*

plans may be combined in the construction of a single dam,—as, for instance, the sides of a dam, when the water is shallow, may be made according to fig. 1, and the centre part with cribs, as in fig. 5.

Plate I. fig. 8. Plate II. fig. 7. The flank of the dam should be secured by being let into the bank and puddled in front, and the earth or rubbish which is thrown in front should be carried up the river against the bank to a greater distance than at other points.

As a general rule, the sides of a dam should be first constructed and the abutments made good: serious accidents have occurred from a neglect of this precaution. Should it be decided to raise the water so as to inundate the banks on each side, the embankment to prevent the water thus raised finding its way round the flanks of the dam, these flanks should be completed before the dam itself is closed. This embankment may be formed of earth: its section may be as in fig. 7, about 3 feet thick at the top, which should be about 1 foot above the highest water line; the up-stream slope at least 2 of base to 1 of height, the down-stream 1 base to 1 of height: in case the soil is light and porous, it will be necessary to excavate a trench in the line of the embankment about 2 feet into the ground, and about 2 feet wide; to puddle this well with clay, and to form a wall of the same through the centre of the embankment till above the water line, as in fig. 7, to render it water-tight. Where a current can act upon it, the base may be protected by stones and by planks, or fascines pinned down parallel to its direction. In all cases ample provision should be made for the passage of the waste water: when it is not allowed to pass over the dam, waste channels should be made, and the passage of the water through these regulated by sluices either self-acting (which is the safest plan) or worked by men. Great care must be taken that the action of the water through these sluices does not tear up and wash away the ground below to an extent to endanger the structure. Aprons (constructed as before described) must be laid in rear of the sluices, except when these are fixed upon rock, and must be carried down to a distance proportional to the body of water discharged, and to the fall, also taking into consideration the nature of the soil.* W. D.

DEFENCE OF BUILDINGS AND VILLAGES.†

OF PLACING BUILDINGS, &C. IN A STATE OF DEFENCE.

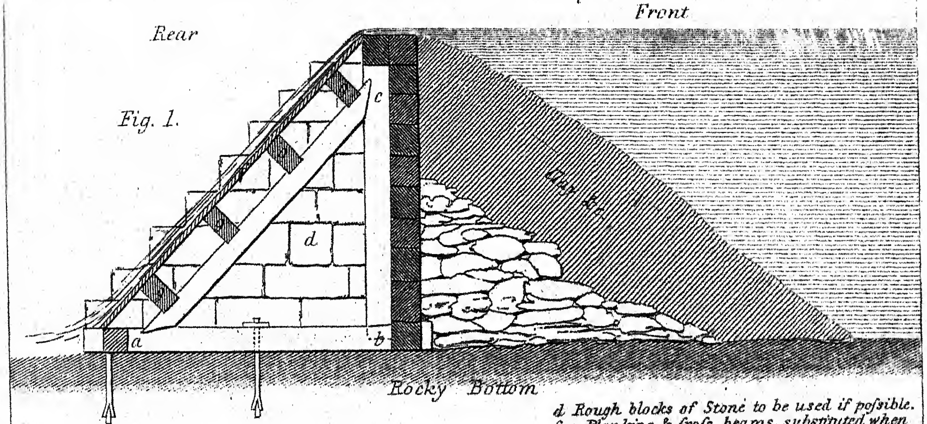
If a building forms part of a general line of defence, or is in the contour of the works round a town or village, the front and sides only may require being prepared for defence, for a force must not be shut up without a special object: if, on the contrary, it is an independent post, to be defended to the last, and is open to attack on all sides, every point must be equally looked to, and the means of retreat and of reinforcing it must be preserved, if considered necessary under the circumstances.

The great art of making a defensible post out of buildings, and the out-houses and walls that usually surround them, consists in selecting from the mass of objects before you what will answer the purpose, and sacrificing every thing else, making use of the materials to strengthen the part you wish to fortify. It is more difficult to state any precise rules for such proceedings than for laying out works in the field; for in one case you generally have a choice in the form of your intended works, and a better

* Bridges may often be converted into excellent temporary dams by blocking up the archway; taking care that the mass thus formed is sufficient to support the accumulated body of water, which must not be taken for granted with most bridges.—*Ed.*

† By Lieut.-Colonel Jebb, C.B., R. E.

Section of a Dam on a Rocky Soil.



d Rough blocks of Stone to be used if possible.
f g Planking & Cross beams, substituted when d cannot be obtained; the interior to be filled as in Fig. 2.

Section of a Dam in a Soft Soil.

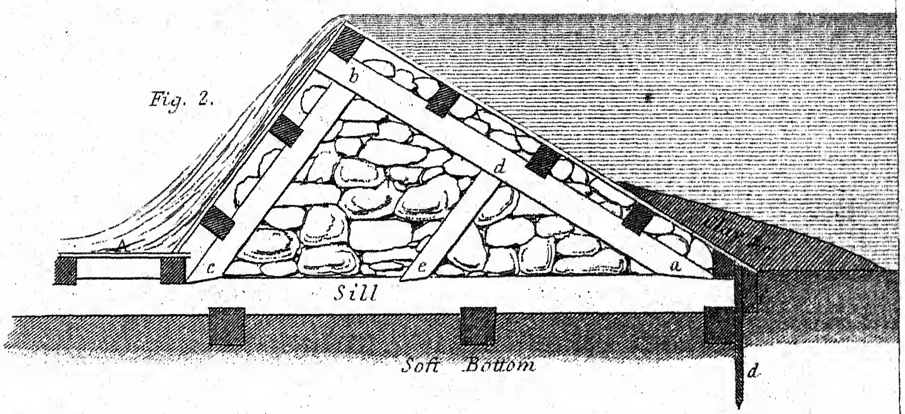
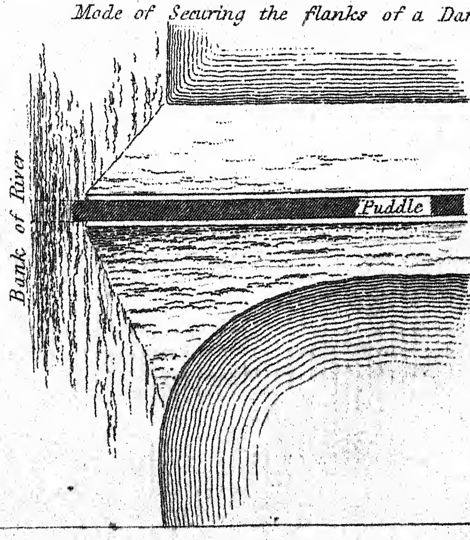


Fig. 8.
Mode of Securing the flanks of a Dam.



J.W. Lowry sc.

John Weale, 59, High Holborn, 1846.

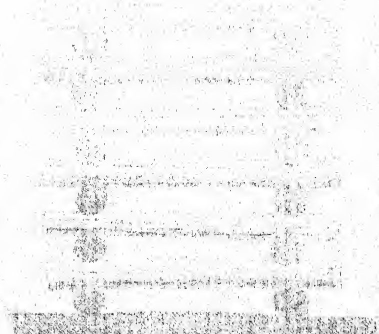


Fig. 3
Section of a Dam on soft soil where Timber is plentiful.

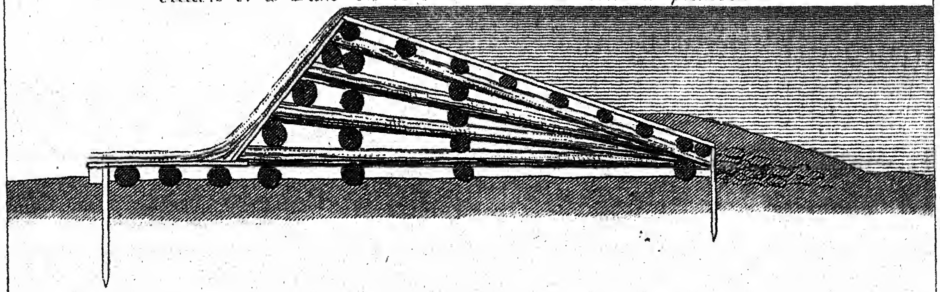


Fig. 4.
Elevation of the rear of Fig. 3. before being planked.

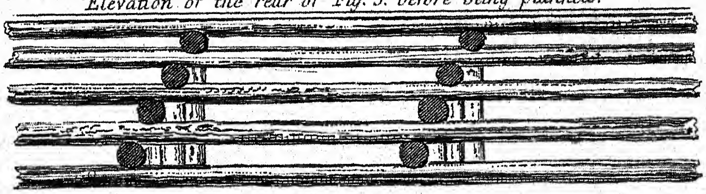


Fig. 5.
Plan of Fig. 6.

Figs. 5. 6.
Cribwork

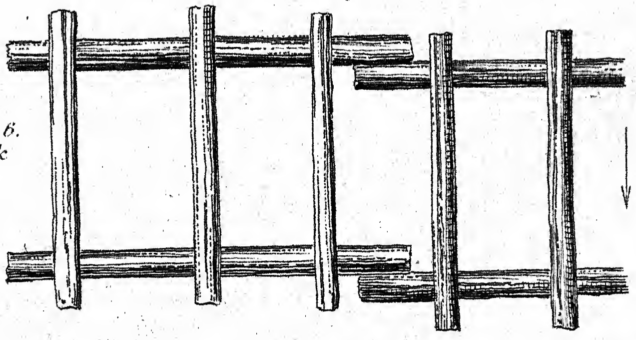


Fig. 6.
Transverse Section of Fig. 5.

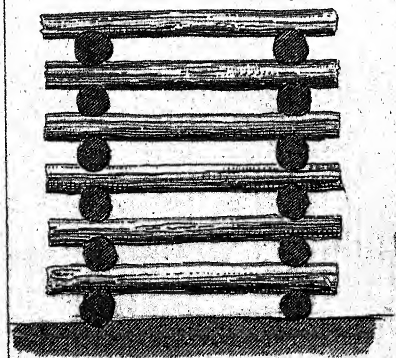
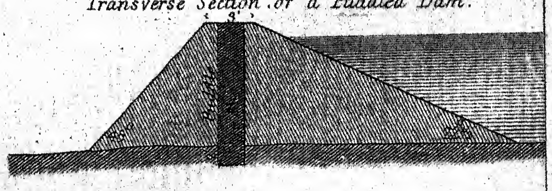


Fig. 7.
Transverse Section of a Puddled Dam.



John Weale, 59, High Holborn, 1846.

J.W. Lowry, fc.

opportunity of arranging what you have to execute under the direction of some general principles.

The principles of defence must be taken into consideration as far as they will apply, and if with a knowledge of these principles an Officer is practically acquainted with the means that are usually employed for strengthening such posts, a very little experience will enable him to arrange his plan, and set his men to work with a confident expectation that in a very few hours he will be able to enliven a peaceable domicile by converting it into a respectable fortress.

The objects now under consideration are churches, country-houses, factories, prisons, or other substantial buildings; and as there is but little difference in the mode to be pursued for placing any of them in a state of defence, an explanation of the details applied to a single house will perhaps be sufficient to convey an idea on the subject.

What has before been said of the points requiring attention in the selection of a military post will be applicable if a choice is to be made among buildings: thus, a building proper for defensive purposes should possess some or all of the following requisites:

First. It should COMMAND all that surrounds it.

Second. Should be SUBSTANTIAL, and of a nature to furnish materials useful for placing it in a state of defence.

Third. Should be of an EXTENT PROPORTIONED TO THE NUMBER OF DEFENDERS, and only require the TIME AND MEANS which can be devoted to completing it.

Fourth. Should have walls and projections that mutually FLANK each other.

Fifth. Should be DIFFICULT OF ACCESS on the side exposed to attack, and yet have a SAFE RETREAT for the defenders; and

Sixth. Be in a situation proper for fulfilling the object for which the detachment is to be posted.

A church will be found more usually to unite all these good properties than any other building.

It may be remarked, that though good strong walls are an advantage, yet their thickness should be limited to 2 or 3 feet, from the difficulty there would be in piercing loopholes; unless when they are likely to be battered by artillery, in which case the musketry must be confined to the windows, and the more solid the walls are, the better. It should also be remembered that brick houses and walls are preferable, on several accounts, to those built of stone; for when exposed to artillery, a round shot merely makes a small hole in the former, but stone is broken up in large masses, and dangerous splinters fly from it in all directions. It is much easier also to make loopholes through brick-work than through masonry. Wooden houses, or those made of plaster, are to be avoided, from the facility with which an enemy can set fire to them, and they are frequently not even musket-proof. Thatched houses are equally objectionable on account of fire, unless there is time to unroof them; and after all it must not be forgotten that earthen works, when exposed to artillery, are to be preferred to houses, so far as affording security to the defenders is concerned. In seeking this security, however, it should be borne in mind that they are not so *defensible;* for troops cannot be run into in a house, but they are not exempt from such an intrusion in an earthen work of the nature under discussion. The two together can be made to form a more respectable post than *either* can be made into singly, for the merits of both will be enhanced, and the defects be modified by the union. A building is therefore at all times a capital base to go to work upon. The walls may be partially protected from cannon-shot by throwing up earthen parapets round it, and the house may 'reciprocate' by acting the part of a keep, and

afford the garrison a place of refuge, in which they may either defend themselves with advantage, or, if it 'suits their book,' resume the offensive, and drive the assailants out again.

An Officer will be able to make his selection at first sight, with reference to most of these points, but it requires a little more consideration to determine whether a building and its appliances are convertible into a post, of a size proportioned to the force under his command. The average number of men, however, proper for the defence of a house may be roughly estimated on some such data as the following;—that in a lower story it might generally be proper to tell off one man for every 4 feet the walls measured round the interior:* in the second story one man for every 6 feet, and in an attic or roof one man for every 8 feet. For example, if a house of three stories high were found on pacing it to measure 140 feet round the interior walls, the number of men for its defence on the above data would be determined thus:

Feet.

$\frac{140}{4}$ would give 35, which would be the number of men for the lower story;

$\frac{140}{6}$ would be about 23 men for the second floor;

$\frac{140}{8}$ would be 18 men for the attic;

making a total of 76 men for the three stories; to which about one-sixth of the whole, say 14 men, should be added as a reserve, altogether forming a garrison of 90 men. If there were out-buildings or walls in addition, the number of men required for their defence would be determined in a similar manner by assuming certain data adapted to the circumstances as a guide in the calculation.

These numbers are not to be considered *definitive*, but merely to convey an idea on the subject; for if a detachment were much weaker in proportion to the extent, a vigorous defence might still be made: the force might be concentrated where most required, as it is not a matter of course that a place will be attacked on all sides at once; or if a building were found so large that the disposable force would be too much disseminated, or if there were a want of materials and time for putting the *whole* of it in a state of defence, a *part* of it only might be occupied.

Should there exist any doubt about having sufficient time to complete all that might be wished, it would become matter for consideration what were the points which it would be of the greatest importance to secure first, so as to be in a condition to repel an *immediate* attack, because such points would naturally claim attention to the exclusion of all others.

In such a case, it might be well to employ as many men as could work without hindering each other by being too crowded:

Firstly. To collect materials and barricade the doors and windows on the ground-floor, to make loopholes in them, and level any obstruction outside that would give cover to the enemy, or materially facilitate the attack.

Secondly. To sink ditches opposite the doors on the outside, and arrange loopholes in the windows of the upper story.

Thirdly. To make loopholes through the walls generally, attending first to the most exposed parts, and to break communications through all the party-walls and partitions.

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* Pacing round the outside of the house, and making an allowance for the thickness of the walls, would be the easiest way of determining the interior dimensions.

Fourthly. To place abattis or any feasible obstructions on the outside, and to improve the defence of the post by the construction of tambours, &c.

Fifthly. To place out-buildings and garden walls in a state of defence, and establish communications between them. To make arrangements, in the lower story especially, for defending one room or portion after another, so that partial possession only could be obtained on a sudden rush being made. These different works to be undertaken *in the order of their relative importance*, according to circumstances; and after securing the immediate object for which they were designed, they might remain to be improved upon if opportunity offered.

An endeavour will now be made to explain the mode of executing these works in the order in which they are mentioned.

COLLECTING MATERIALS.

The materials that will be found most useful in barricading the passages, doors, and windows, are boxes, casks, cart bodies, bricks, stones, cinders, dung, &c., and timber of any sort that comes to hand: if it cannot be found elsewhere on the premises, the roof and floors must be stripped to furnish what is required.

BARRICADING DOORS.

In the application of these materials, the boxes and casks filled with cinders or dung, and placed against the doors to a height of 6 feet, will prevent their being forced open, and loopholes may be made through the upper portions, which can be rendered musket-proof, to protect the men's heads: short lengths of timber piled one upon another to the same height, leaving a space between any two of them in a convenient situation for firing through, and their ends being secured in the side walls of a passage, or propped with upright pieces on the inside, will effect the same object; or a door may be loosely bricked up, leaving loopholes, &c.

If it is probable that artillery will be brought up for knocking away these barricades, and so forcing an entrance, a passage may be partially filled with dung or rubbish to the thickness of 8 or 10 feet, or thick beams of timber may be reared up on the outside of a door, and the interval filled with the same, or with earth, if more convenient.

A small hole, 3 feet square, may be left through an ordinary barricade for keeping up a communication with the exterior; but for effecting a retreat, or making sorties, it will be necessary to make a door musket-proof* by nailing on several additional thicknesses of plank, and arrange it so as to open as usual, or to contrive something on the spot which shall equally protect the men when firing through the loopholes, and yet be removeable at pleasure.

BARRICADING WINDOWS.

Windows do not require to be barricaded so strongly as doors, unless from their situation an entrance may easily be effected, or an escalade be attempted. The principal object is to screen and protect the defenders whilst giving their fire; anything, therefore, that will fill up the window to a height of 6 feet from the floor, and that is musket-proof, will answer the purpose. Thus two or three rows of filled sand-bags
Plate I. laid in the sill of a window, (fig. 1,) or short lengths of timber, would do; or a carpet, a mattress, or blankets rolled up, would be ready expedients. Loopholes would in all cases be arranged, whatever materials were used. If time presses, and windows could not be blocked up, one means of obtaining *partial* security would be to hang a great coat or blanket across the lower part of them as a screen, and make the men fire

* See article 'Barricade,' p. 130.

beneath it, kneeling on the floor. The glass should be removed from windows before an attack commences, as it is liable to injure the defenders when broken by musketry.

LEVELLING OBSTRUCTIONS OUTSIDE.

Any shrubberies, fences, or out-buildings, within musket-shot, which would favour an attack by affording cover to an enemy, and allowing him to approach unperceived, it is essential to get rid of as soon as possible. The trees should be felled, leaving the stumps of different heights, so as to encumber the ground, and the materials of walls, &c. must be spread about with the same view; but whatever is convertible for barricades should be carried to the house. The thatch from roofs, and any combustibles, should also be removed or destroyed.

DITCHES IN FRONT OF THE DOORS, &c.

As a means of preventing a door being forced, a ditch may be dug in front of it, about 7 feet wide and 5 feet deep: such a ditch also is necessary in front of the lower windows, if the loopholes cannot be conveniently made high enough from the outside to prevent an enemy reaching them, as would be done in managing matters for the defence of walls. These partial ditches may afterwards be converted into a continued ditch all round a house if opportunity offers, as it would contribute to the defence of the post. The floors may also be taken up on the inside, opposite the doors or windows open to attack.

LOOPHOLES.

Plate I. If the walls are not too thick, they may be pierced for loopholes, at every 3 feet, in the spaces between the windows, &c. (Fig. 1.) These loopholes can be knocked through with a crow-bar, or even a pickaxe: they should be just such a size as to enable you to see your enemies without being seen by them.

Two tiers of these loopholes may be made if opportunity offers, and a temporary scaffolding of furniture, benches, casks, or ladders, &c. erected for firing from the upper ones: on the lower story a row of loopholes may be made close to the ground. The floor must, in this case, be partly removed, and a small excavation made between the beams for the convenience of making use of them. Just under the eaves of a roof there is generally a place where loopholes can be made with great facility, and a tile or slate knocked out here and there with a musket will give other openings from which an assailant may be well plied as he comes up.

COMMUNICATIONS.

A clear communication must be made round the whole interior of the building, by breaking through all partitions that interfere with it; and for the same purpose, if houses stand in a row or street, the party-walls must be opened, so as to have free access from one end to the other: means should likewise be at hand for closing these openings against an enemy who may have obtained any partial possession. Holes may also be made in the upper floors to fire on the assailants, if they force the lower ones, and arrangements made for blocking up the staircases, with some such expedients as a tree, prepared in the same manner as for an abattis, or by having a rough palisade gate placed across. Balconies may be covered or filled up in front with timber or sand-bags, and made use of to fire from downwards.* Fig. 2. (See Abattis, p. 32.)

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* See article 'Machicoulis.'

ABATTIS.

The partial levelling of any object on the outside, that would give concealment to an enemy, and favour an attack, is supposed to have been already attended to; but if time admits, after the loopholes, &c. are completed, this system must be extended and perfected, and the formation of a more regular abattis should be commenced, and any other obstruction added that opportunity permits. The best distance for such obstructions, if they are continuous and cannot be turned, is within 20 or 30 yards of a work, or even less, so that every shot may tell whilst the assailants are detained in forcing a passage through them.

TAMBOURS.

If the building that has been selected has no porches, wings, or projecting portions from which flank defence can be obtained, it will be advisable to construct something of a temporary nature to afford it.

Stockade-work offers a ready means of effecting this object: it may be disposed in the form of a triangle, projecting 8 or 10 feet in front of a door or window (fig. 4), planted in the manner and with the precautions of having the loopholes high enough. A small hole should be left in the barricade of the door or window to communicate with the interior. Three or four loopholes on each face of the projection, cut between the timbers, will be found very useful in the defence. These contrivances are usually termed tambours, and if constructed at the angle of a building, will flank two sides of it. (Fig. 3.)

Plate I.

OUT-BUILDINGS AND WALLS.

When the defences of the main building are in a state of forwardness, any out-buildings or walls which have been found too solid to be levelled at the moment, or which have been preserved for the chance of having time to fortify them, and thus to increase the strength of the post, must be looked to. They may be placed in a state of defence by the means already described, and separate communications should be established between them and the principal building by a trench, or a line of stockade-work, and by breaking through the walls when necessary. In this way a post may be enlarged in any required proportion, by turning all objects that present themselves, such as out-buildings, sheds, walls, hedges, ponds, &c. to the best account; first taking the precaution to secure what is absolutely necessary for *immediate* protection, and for placing it in a state to be defended on the shortest notice.

An exterior wall or fence, tolerably close to a house and parallel to it, may be retained for the purposes of defence, without the danger of affording cover, and thus facilitating an attack, by throwing up a slope of earth on the outside of it, or planting an abattis in the same situation (fig. 5). An enemy would thus remain completely exposed, and it would be worse than useless to him.

Plate II.

If a post of the description under consideration were composed of two or more buildings, and it were to be left to itself, and were open to attack on all sides, the stockades or trenches, forming the communications between them, would obviously require to be so arranged as to afford cover, and the means of resistance *on both sides*. This would be effected by merely making them *double*, as shewn in figs. 5 and 7; but for greater security, the exterior of such communications should be laid under fire from the buildings at their extremities.

In arranging the defences of such posts, it is an essential point to make each portion of them so far independent of the others, that if any one part, such as a building for instance, be taken, it shall not compromise the safety of the remainder, or materially impair the defence they will make by themselves; so that whilst free communications are essential in most cases to a vigorous defence, the means must be

at hand for instantly cutting them off by some such expedients as would be afforded by a loopholed musket-proof door, or rough gates, or by letting fall a tree prepared as for an abattis, and which, till wanted, might be reared on its end in the situation required; having previously secured the means of bringing a close fire upon it.

It is incredible what a defence may be made in a substantial building, if it has been properly prepared, and the right sort of people have been put into it. The siege of Saragossa, in 1809, affords a proof of how much may be done in defending streets and houses. The French were reduced to the delay of an attack *secundum artem*, and no impression was made but by the regular means of artillery and mines. It is to be recollected, however, that the houses could not be set on fire, and the walls were of extraordinary thickness.

Plates III. & IV. Figs. 8 and 9 are given as examples of a country-house and out-buildings which have been prepared for defence in the manner described.

DEFENCE OF VILLAGES.

Though the placing a village in a state of defence argues that larger forces, and Officers of higher rank and more experience, are engaged, than has hitherto been contemplated in the smaller posts that have been discussed in this article, yet, in cases of emergency, much responsibility may still devolve on a young Officer in executing, and in some measure planning portions of the work: the subject therefore will be briefly noticed, though the details already entered into embrace much of the information which would enable him to make himself useful on such an occasion.

As a village is only the extension of a smaller post of the same nature, the general requisites adverted to in the preceding, when treating of such posts, should be looked for in determining whether or no it is favourable for defensive purposes, and whether it offers such facilities for executing the necessary works as that they can be completed in the time that can be devoted to them.

Thus a village should not be commanded;—it should furnish materials proper for its defence, and be of a nature not easily set on fire;—of a size proportioned to the force designed to occupy it;—should be difficult of access, &c. In addition to which there should be some substantial buildings near the exterior, to be converted into strong salient points of the general line; and in most cases a church or large building in the interior, to serve as a keep, would be a desideratum. There should likewise be a facility for forming a connected line all round, or on the front and flanks, if they only were to be fortified. If it were situated on a height, some of the sides of which were inaccessible, or if it were partially skirted by a river or marsh, so much the better; it would be more easily rendered defensible.

An idea may be formed of the extent the works should have in reference to the disposable force by making a rough estimate on the principles advanced, bearing in mind that they will admit of considerable latitude either way.

Villages may be required to be intrenched under a variety of circumstances, but as far as the works themselves are concerned, two cases only require consideration, viz. when they are left *open in the rear*, and when they are *enclosed all round*.

Under the first consideration;—if a village is to be held as an advanced post, or forms part of a general line, in front of an army, and it can receive instant support when attacked, it will generally be left *open in the rear*, and only be strengthened in front. To effect this, the first attention of an Officer, after determining his general plan on the principles already laid down, would be directed to the readiest means of stopping up all the streets, roads, and lanes on the front and flanks of the exposed side, with such temporary obstructions as could be most expeditiously formed.

Men would be detached to bring to the spot selected whatever materials would assist in the work, such as waggons, carts, ploughs, harrows, trees, gates, rows of paling, furniture, chains, ropes, &c. With these there would be no difficulty in creating obstructions in a very little time, that would interfere with the visits of cavalry, and break the order of infantry, and thus offer impediments to an immediate attack. They should be placed in those situations where they would afterwards be of some use, either as obstacles in front of other works proposed to be executed, or in the principal line itself, and therefore to be improved upon; for, if possible, NO LABOUR SHOULD BE THROWN AWAY.

Whilst these works were in progress, an Officer would have more leisure to examine his whole post in detail, in doing which he would find it convenient to make a memorandum of the number of men that could be employed to advantage, and the probable time it would require to complete each of the works he proposes for its defence, so as to suit them to his means. These being afterwards confided, in distinct portions, to the active superintendence of intelligent young Officers, would insure their being done in less time than were he to attempt *ubiquity*, in looking after them all himself.

In arranging his general plan, he will have selected, as far as circumstances have favoured him, some good substantial buildings, not exceeding the effective range of a musket, say 150 or 200 yards apart, for the most prominent or salient points of his line, which will be prepared for defence, as explained in the foregoing pages; or he will have decided on occupying those points with the best breastworks or stockades he can make in the time; and availing himself of all buildings, hedges, ditches, walls, or inequalities that lie between them, he would proceed to make arrangements for connecting them by breastworks, trenches, stockades, or some other of the means already described, and on the principles laid down respecting flank defence, and giving a good fire to the front. His working parties would be distributed accordingly, and it would be his constant endeavour to obtain the best cover, and to create the greatest obstructions, with the least possible labour. No exertion should be spared until the enclosure were perfect, and in a state to be defended; all hands should be employed night and day, if necessary, in alternate reliefs, and every arrangement should be made with this view: such points as required the greatest attention might then be progressively improved upon.

All the streets and roads open to attack should be shut up by good barricades constructed in rear of the temporary obstructions that have been created. These barricades may be made, if time admits, by sinking a ditch 7 or 8 feet deep, and forming the earth into a substantial breastwork (fig. 9), planting palisades, &c. if opportunity offers. Or if not exposed to artillery fire, stockade-work would be very effective; but if time should press, casks, boxes, or cart bodies, arranged in order and filled with earth, stones, dung, or cinders, would be a ready expedient. Bales of goods, hogsheads of sugar, sacks of malt, or even the rolls of cloth out of a tailor's shop, would be very convertible to such like purposes if they came to hand.

The mass should be raised 6 or 7 feet high, and a banquette or step be arranged for firing over it. The access should be as much obstructed as possible, and above all, every house in the neighbourhood should be loopholed, so as to give a good flanking fire over the ground in their front.

If several barricades are made in a street, to be disputed in succession, the means of retreat through them must be preserved. This may be effected by disposing the lines as already explained, by which the passages would be readily closed and defended; and a communication should be made from house to house on each side the street, for firing on an advancing column.

In front of his post, it would be an object to destroy all houses within range of musketry,—to level all fences, and fill up all ditches, &c. that ran *parallel* to the general line he had taken up within that distance, so that an enemy might find no cover whatever: such fences and obstructions, however, as ran *perpendicular* to his post, and that could be seen from it on both sides, might remain, as they would interfere with the flank movements of an attacking force, and embarrass his approach. Within the line of works, on the contrary, all fences and obstructions that are *perpendicular* to the line, and interfere with a free communication from right to left, should be cut away. Those that are *parallel* should be preserved, as affording protection to a retreat and further means of defence, if the outer line were forced. It is very important to have a second or even a third line of defence prepared, if the position of the buildings and localities admit of such an arrangement, so that if troops are driven from one line by a superior force, they may find another and another in their rear, all ready for occupation.

Such posts as these, when situated in a plain before the front of an army, or as a point of *appui* for one of its wings, have a very important part to play. But to enable an inferior force to derive the greatest possible advantage from them, they should not only be strengthened in themselves, but every obstruction in rear of them should be levelled, so that there may be facility for the movement of all arms for their immediate support when attacked. If there are fences or walls in existence which cannot be cleared away, good broad roads should be made through them: on the other hand, if a force in connection with such a post is on equal terms with an enemy, so that the offensive may be taken up, and a forward movement made, as opportunity offers, it would be injudicious to have obstructions in front, which might in that case be in the way. Probabilities and circumstances alone can decide what is best to be done.

Under the second consideration, if a village were to be occupied as an independent post, to be defended to the last, energy and intelligence must be drawn upon to the utmost, to place it in the best possible state. The details of execution will be similar to those already explained, as well as the general principles which regulate the whole; but it must be *enclosed all round* with an outer line, and if possible some strong building, such as a church or jail, must be looked up and put in a state of defence, and supplied with provisions, ammunition, &c., to which, as a citadel or keep, the defenders may retire, and there fight the battle over again, with a better chance of success, if driven in by an overwhelming force.

This keep should be centrally situated, in a position covered from the enemy's artillery, and commanding the principal roads or streets. It should be of a nature not easily set on fire, and should have good and assured communications with all the outworks. Advantage must be taken of any walls and out-buildings surrounding whatever has been selected as a keep; and they should be converted into outworks for strengthening it as an independent post. These outworks are the more necessary, as besides the additional strength they will impart, they will be found of essential service in securing a retreat into it; for a reserve quietly occupying them ought to command considerable respect from an enemy, however hotly he might be in pursuit.

If suitable buildings were to be found, and there were men enough to defend them, several such keeps might be prepared; and on the contrary, if a village should be of too great an extent for the force thrown into it, a portion of it only might be strengthened, and the remainder be separated or destroyed; or the defence might be confined to some principal building. Plate I. is taken from sketches inserted in some Instructions published by the French Imperial Minister of War in 1814.* In this

* Slightly modified in correction of some defects.

sketch the existing buildings and streets, &c. that have been taken advantage of, for defensive purposes, will be easily distinguished from the new works which it has been necessary to add for a more effectual application of the principles adverted to. On one side the village is covered by a river and an inundation, which of themselves present a barrier, and the bridges which communicate with the country are shut up with temporary works of the nature explained, so as to render it tolerably secure against an attack from that quarter.

On the other side the river the buildings do not appear to have been disposed very favourably for the defence, which has made it necessary to construct a variety of new works. These have been laid out so as to give fire to the front and reciprocal flank defence; they consist of stockades, and earthen breastworks with ditches in front of them. The streets, it will be observed, are all barricaded. Communications are also broken through all the houses in the contour close to the parapets. The principal buildings, probably a church and a prison, will be easily recognized; they have been converted into keeps, and appear well situated for the purpose of supporting, and, if necessary, of receiving or covering the retreat of the defenders of those portions of the outer lines which are contiguous to them.

Such works as are here treated of are not supposed to be proof against round shot, which is a defect that must be charged against the want of time to make them so: if, however, troops are secured from observation, and from the immediate effects of case-shot, bullets, sabres, and bayonets, which are far more destructive, and they are besides placed in an attitude to resist a superior enemy, and above all to *gain time*, it will be admitted that a great object has been attained at a trifling expense of labour.

Numerous instances might be adduced where posts, fortified in the greatest haste, have offered a more protracted and effectual resistance than more regular and more imposing works have done; which may partly be attributed to measures of evident necessity being adopted, which might have eluded previous calculation; and to an enemy generally coming upon them unprepared with the requisite means for their attack.

It will ever be found that a man of energy and resource will do more for himself in such a case of emergency than a man of rule; and it will be encouraging to a young Officer to reflect, that zeal and intelligence, aided by a very little practical knowledge, will go far to effect all that could be expected from scientific acquirement and greater experience.

GUARDING AND DEFENDING AN INTRENCHED VILLAGE.

The general disposition of a force for the defence of an intrenched village would be influenced by the principles adverted to, as far as the difference of locality and circumstances will permit of their application; and as the chief defensive works would usually consist of a combination of buildings and intrenchments, &c. which have been separately under consideration in the preceding pages, it will be needless again to enter into the *local* disposition of the defenders of such works, or the means which they are to resort to for resisting an attack. A village, however, may be of considerable extent, calling for additional precautions and defensive measures, corresponding to its importance as a military post: a few further remarks on the subject may therefore not be superfluous, as they may at least serve to combine, under one general plan, the separate defences of such detached portions as would be under the superintendence of individual Officers, and thus render each part more intelligible.

To guard against a surprise, and to be in readiness to repel an attack at any moment, and in any quarter, are objects demanding equal attention, and are the main-

spring and basis of all defensive measures;—the latter, by judicious internal arrangements, in occupying the different works to advantage,—posting the pickets, reserve, and support, so as to enable them to perform their respective duties with decision and effect,—appointing convenient situations for assembly on the first alarm,—judiciously quartering the troops, &c.

In making these preliminary arrangements for the defence, a Commander would never lose sight of the great importance of getting every man to his post in the least possible time; and when he had ascertained by false alarms, or other means, what he could trust to in that respect, his next care would be to take such steps as would at least insure sufficient notice of the approach of an enemy, to enable him to dispose his force without hurry, for giving him a warm reception. For instance, it might require half an hour to do this leisurely, and he would therefore, on this supposition, so distribute his outposts, &c. as to feel secure of having the time to himself, after the first alarm was given, and before an attack could possibly be made. If he fails in having sufficient notice to do this, it is ten to one he is beat, for the best measures will be of little avail if they cannot be carried into full effect. It will be needless to harass troops by multiplying outposts so as to secure earlier intelligence than is required; but still it will be an error on the right side to take twenty precautions too many, rather than to neglect a single one. In making his dispositions, therefore, he would endeavour to steer a middle course between two extremes; on the one hand, if troops are overworked in preparing for an attack, and guarding against a surprise, they are thrown out of condition for resisting it when made,—on the other, if all due precautions are not taken for first strengthening the post, and then guarding it, they risk the loss of all their labour in being exposed to a sudden attack, at a time when they are in no form for opposing adequate resistance.

In the distribution of the defenders, too, there are extremes to be avoided; for instance,—if all the parapets and works are manned without regard to the requisite force which should be in reserve for giving support, though the greater number formed for opposing a first shock might lessen the danger of being upset by it, yet a line cannot stand up for any length of time against a column that from circumstances can be brought into contact with it; and when once it is forced at two or three points, the game is pretty nearly up, unless there is something fresh to go to work with. The opposite defect would be in giving undue strength to the reserve at the expense of the parapets, which, from being feebly defended, would not then offer the resistance they ought to oppose. Another such a passage to steer between a Scylla and a Charybdis, and another to that, might be added if these little principles were pursued further; but we may safely trust to common sense suggesting more on the spot under the ever-varying circumstances that arise on service, than the *memory* can supply,—provided that the *simple principles* and *essentials* of the subject have made that impression on the mind which has secured their *saliency*. If they are *at home* when wanted, there is a natural tendency in minor matters to fall into their places and come right of themselves, and we will therefore leave the rough outline as it is.

The proportion of the disposable force to be retained in hand for the reserve would be governed by circumstances, depending on the number of assailable points, and the calls that might be expected to be made upon it for assistance,—perhaps from one-fourth to one-sixth of the whole would not be far off the mark. The remainder would be subdivided for a variety of duties, such as a garrison for each separate house that had been strengthened, and one for the keep,—defenders for the intrenchments, breastworks, and stockades,—pickets, guards, &c.

A strong reserve picket should be mounted at the rallying point of the reserve,

which should be near the centre of the village, in some open place having free communication to all the defences. Another picket would be in the keep, and, according to circumstances, others might be required at different points. An outlying picket or two would be equally necessary in commanding situations beyond the works, and a communication between all of them should be kept up by a chain of sentries, or frequent patrolling. If cavalry form part of the force, some of the outpost duties during the day-time should be intrusted to them, as they can patrol to a greater distance to see what is going on, and obtain information. In the evening they would be replaced by infantry; but if the posts were distant, a few cavalry patrols should be attached, to assist in keeping up the communication, or to gallop in with intelligence. The pickets would of course be accoutred and ready to stand to their arms at an instant's warning, and those for the immediate defence of any distinct portion of the works, such as intrenchments or barricades, should either be hutted or encamped close to the spot, or lodged in the nearest building, if one were found conveniently situated for the purpose: this is essential, for an enemy, if unopposed for even a few minutes, will surmount without difficulty such obstacles as are usually met with in the temporary works that have been treated of.

Every Commanding Officer of a regiment should have a steady non-commissioned officer of each company to sleep within hail of him every night,—one who is perfectly acquainted with the quarters of every officer and non-commissioned officer in his company; so that at any instant orders might be conveyed with the utmost promptitude to any part of the corps, however much it might be distributed. And on the same principle, every Officer in command of a company which was detached should retain the means of readily communicating orders.

The support, too, should be close at hand in the nearest houses, and they should have a hint that there is no necessity for being *shy* about breaking out fresh doors, or doing any thing else that may make their communications more *direct* or *convenient.* On these occasions it should always be borne in mind that a *straight* road is the shortest, and if it is a *wide* one, so much the better, provided it is not one that an enemy can avail himself of. In more permanent works, there is not this extreme necessity for having the defenders of them as it were constantly under arms to repel an attack; for if a sharp look-out is kept, the obstacles presented by deep and wide ditches, stout palisading, &c. will of themselves consume as much time of the assailants as will enable the defenders to repair to their posts, even if it was at rather shorter notice than might be agreeable; but here it is obviously a matter of paramount necessity.

These precautions having been taken for guarding a village against a surprise, and for immediate defence, and the remainder of the force being apportioned according to circumstances for occupying the different works and buildings, it would become an object to quarter them all as close as might be to the scene of their exertions, that there should be no unnecessary delay in getting them to their posts. Each separate detachment should have a sentry to stir them up on the first alarm, and when circumstances required it, they should all sleep on their arms, or they will not make so quick 'a turn out' of it as may be wanted. Every precaution should be multiplied by 2, when the night is dark and tempestuous, as that is the 'time o' day' for a surprise. During the winter too, when men cannot be so much exposed under arms, and human nature is prone to look for scraps of creature comfort, under the lee of anything that will protect them from a keen North-Easter, the attention of Officers cannot be too much directed to enforce these duties, and to see that everybody who ought to be on the alert is so. A single sentry standing with his back up behind a tree or under a parapet, instead of snuffing the morning air with his face the other

way, might cause the sacrifice of the whole post. Indeed, when all has been done that the most zealous watchfulness could dictate, a Commander and most of his people should still 'sleep with one eye open' if the enemy is within a march of him. The best measures that can be devised are not infallible, even by day, and to prevent being *taken short* at night, it is safest to consider that a column of attack, with grenadier caps and mustachios, all teeth, hair and steel, might rise up out of the bowels of the earth, or drop from the clouds, close in front of the defences, at any moment. If you are prepared for such emergencies as these, you may go to bed with the conviction that you are ready for him; and let an enemy then do his worst, you will at least have the satisfaction of not having been outwitted.

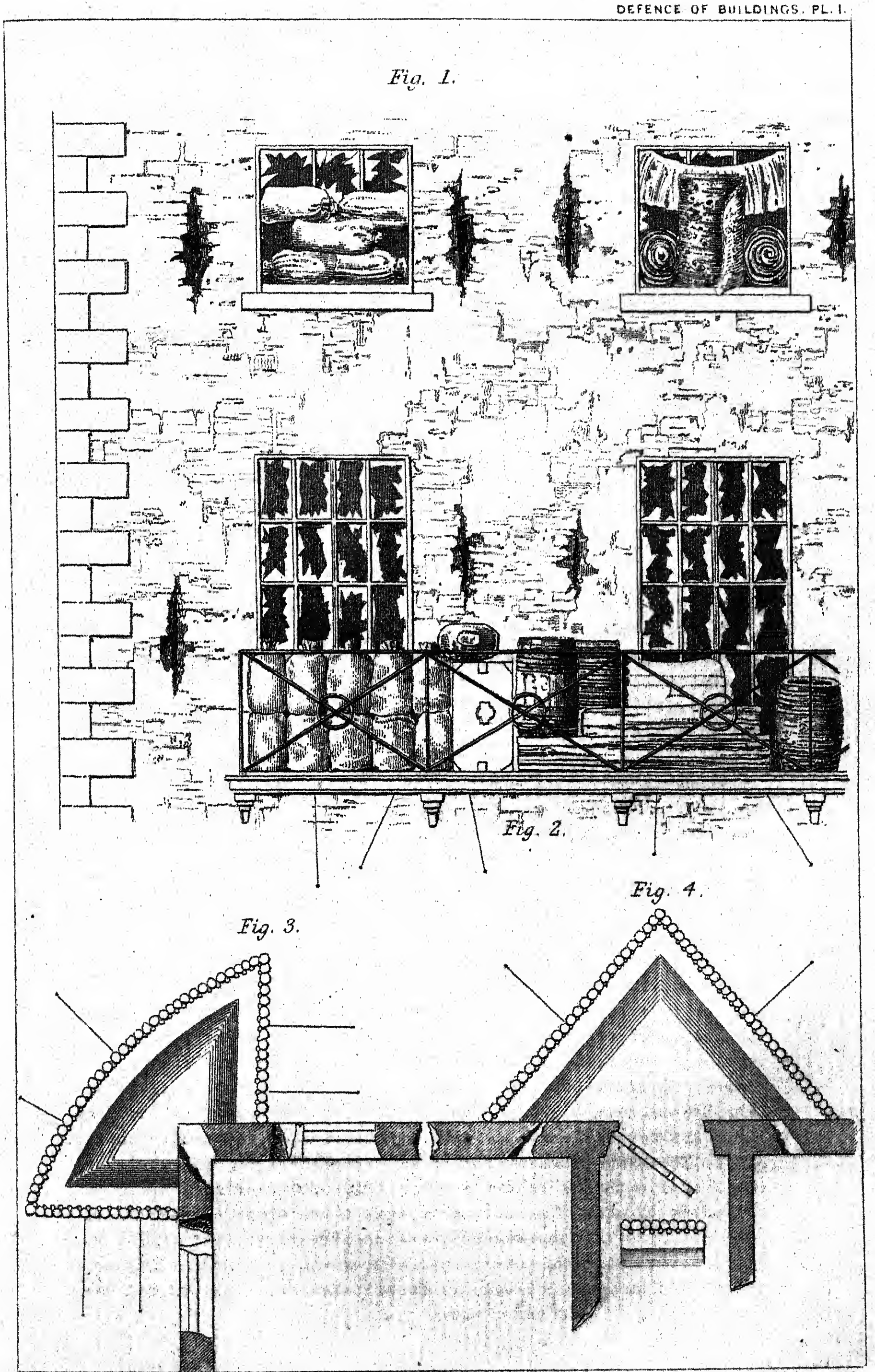
Among other things, it is most essential that every officer and soldier should be thoroughly instructed in the nature of the work he had to defend, and the duties he had to perform, in all the exigencies which prudence could forsee. They should also be perfectly acquainted with every street, alley, or foot-path by which they might have to move, so that on the first alarm, even if the night were as dark as pitch, and they had not time to give themselves a shake by way of toilet, still there would be no confusion or mistake in repairing to their respective alarm posts, and afterwards being posted for the defence according to whatever orders might have been given.

If it should seem desirable, and the garrison is sufficiently strong to afford to make a sortie, it is essential that it should be well timed and vigorously executed, and be in sufficient force to make some impression, either as a diversion in favour of the defenders of the parapet, or to drive the assailants back beyond the obstacles they may have already surmounted. The party may be selected from the reserve and the defenders of the interior of the village, leaving the parapets fully manned as they ought to be. The sorties should be drawn up at the points by which they are to go out, and at the critical moment when the speed of the assailants has been first checked by the opposition they might meet with in front, a furious onset with the bayonet should be made on one or both flanks; and when the object was effected, the troops should retire within the works again, as fast as they came out. The firing from the defences would cease whilst they were engaged, and be resumed with the utmost vigour the moment the front was clear again. Arrangements should also be made for covering their retreat, by being in readiness on the neighbouring parapets to open a heavy fire the instant it was required.

During an attack, the reserve should be within ear-shot of the Commander of the post, or his bugle, as it would be by the instantaneous application of this part of the force at the right moment, that his hopes of remedying any disaster would mainly depend.

Before he determines to strike a decisive blow with so important a body, a Commander should assure himself that the attack is a *real* one, and that the defenders and their support have been unable to deal with it; and when he has made up his mind, he should bring forward the whole or a portion of the force to the spot, as might seem expedient, and make the most impetuous attack possible; for if the reserve is checked, and the original defenders of the work are still in disorder, it will be up-hill work to regain the ascendancy. The whole force should rally, and be reformed at some little distance, and a desperate attack be directed on the front and flanks of the assailants, who we may reasonably conclude would not be in the very best order for receiving it; and if it were successful, and they were fairly driven back, all would be right again. The reserve would regain its post, the defenders and the support would do the same, and everything would then be ready to play the rubber out.

If, however, a Commander sees that he is overmatched, either by the combinations or numbers of his enemy, it remains for him to conform to circumstances, and shew that prudence is the better part of valour.



J. W. Lowry, fc.

Fig. 6.
Elevation of Fig. 7.

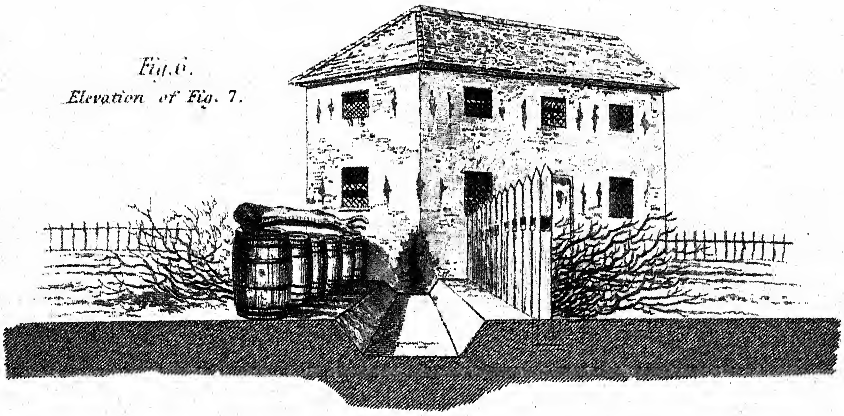


Fig. 5.

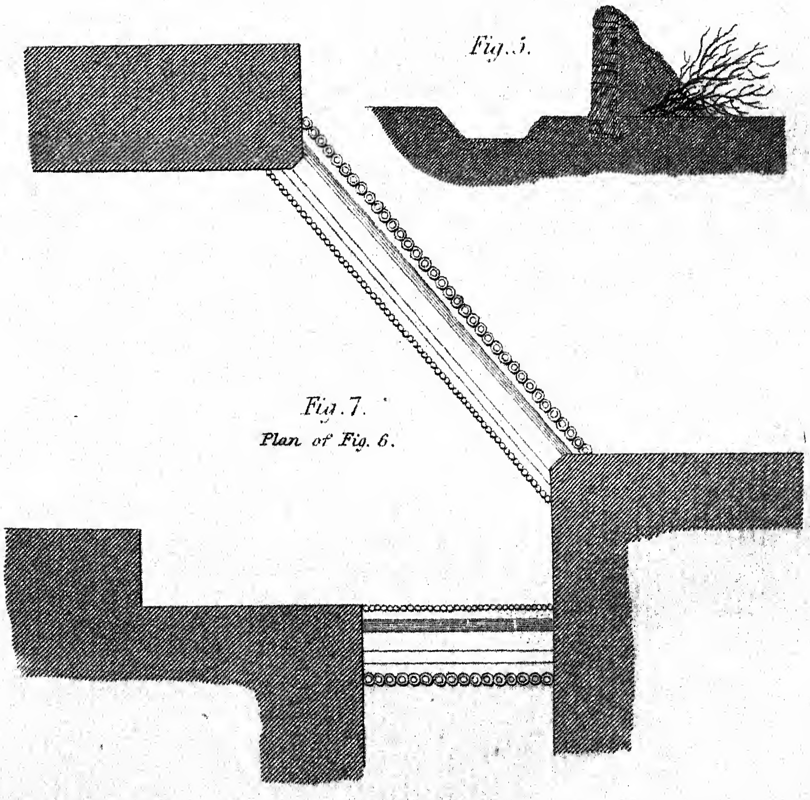
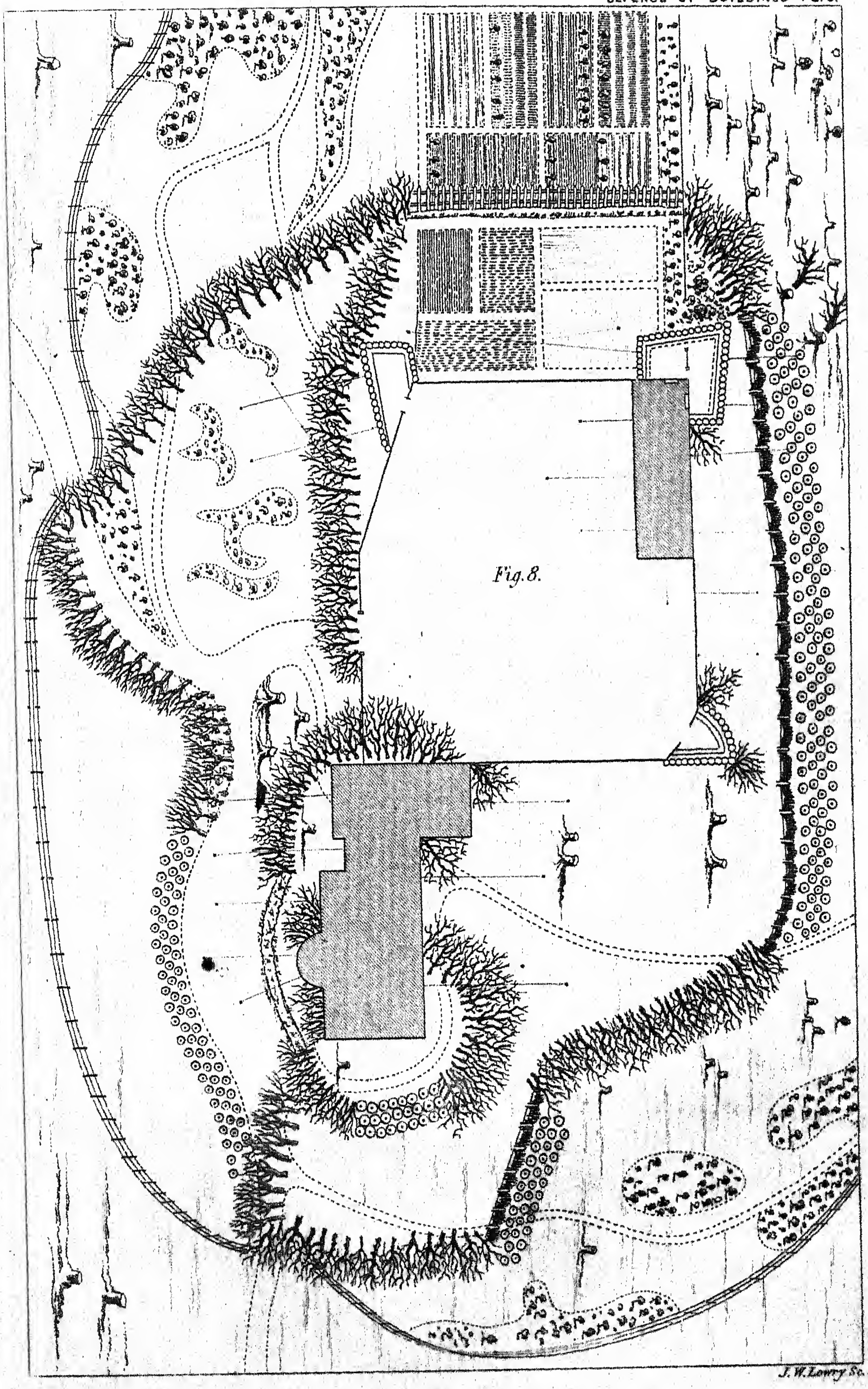


Fig. 7.
Plan of Fig. 6.

J. W. Lowry sc.

John Weale 59 High Holborn 1845.



John Weale 59, High Holborn, 1846.

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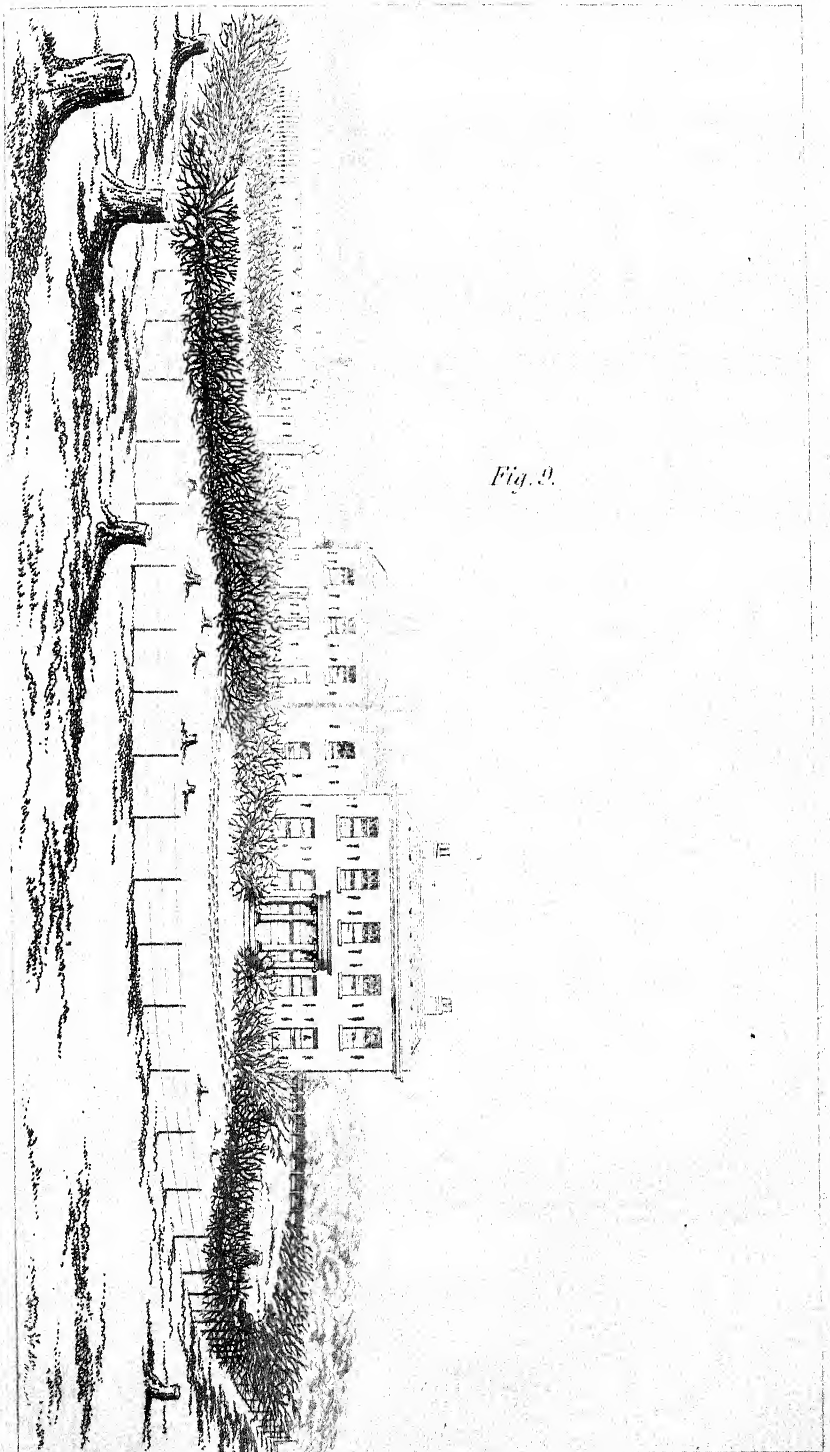
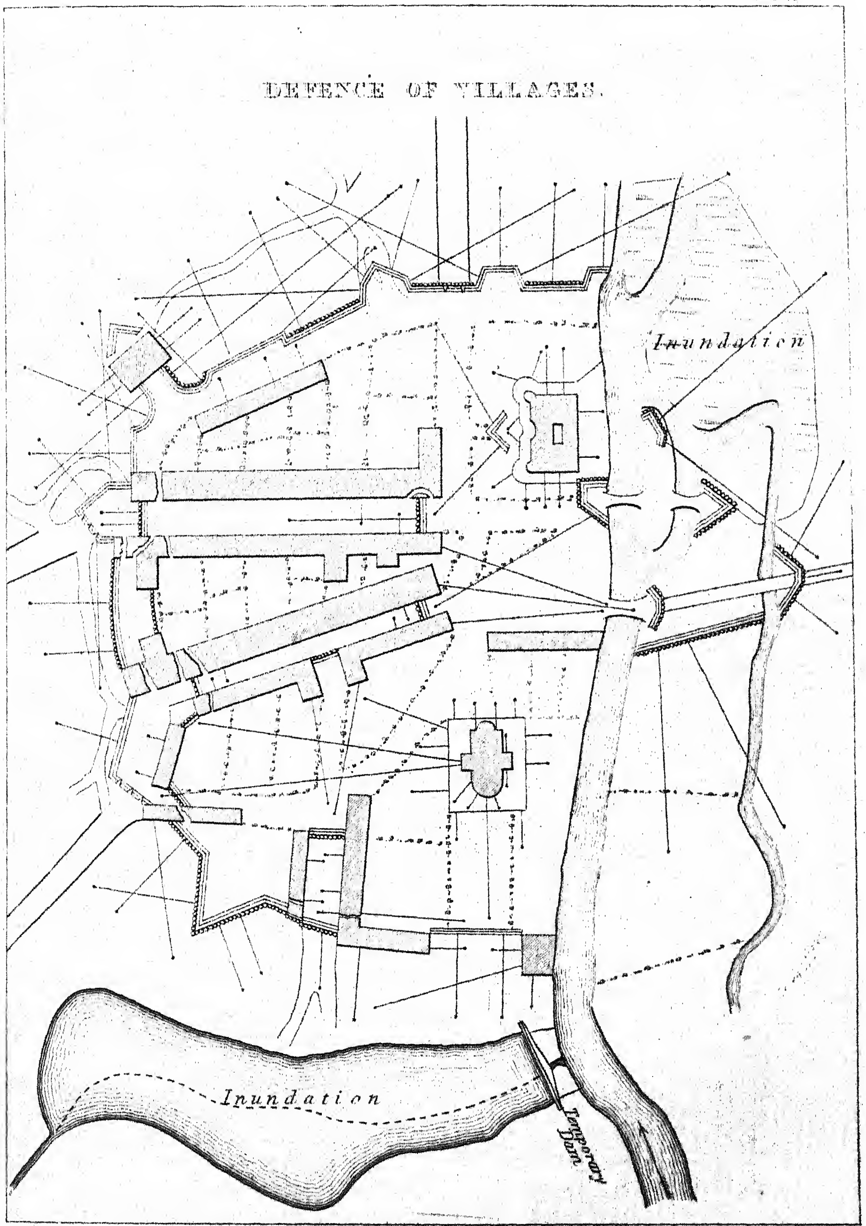


Fig. 9.

J.W. Lowry fc.

John Weale, 59 High Holborn, 1846.



J. W. Lowry sc.

John Weale 59 High Holborn 1845.

It is stated that villages may be intrenched under different circumstances, the chief of which are,—whether the force defending them is to be supported from the flanks or rear during an attack, or whether the post is to be considered independent of other operations, and therefore to be defended to the last by the troops thrown into it. In the former case, the communication with the rear and on the flanks, and the means of holding the ground by a succession of defensive lines, would have been previously arranged, which would give the supporting troops the opportunity of acting with effect, whilst the original force was re-forming. In the latter, a keep would have been indispensable, and the reserve would protect the retreat of the different detachments from the more open works of the contour into this stronghold.

Much however would have to be done on both sides before a retreat to the keep or anywhere else would be thought of; and as *much* cannot be done without an expenditure of *time* to do it in, the object of defending the post at all might still be fulfilled, whatever the issue of the combat might be; for in all combined operations we may say with a French author, '*Que le but de l'art défensif est de gagner du temps.*'

More important ends than saving a little time are however frequently gained at the trifling cost of taking the trouble to strengthen a post; for the determined attitude which all the troops affected by the operation are enabled to assume, from feeling a proper confidence in the resources which may be acquired by these means, either for defending themselves or for repelling an attack, may have the effect of warding off a threatened blow altogether. There is certainly something in the bristling look of an abattis, and the mischievous aspect of a wall or building full of loopholes, enlivened by an occasional appearance of a cap or a bayonet, that is more calculated to induce a little reflection than when dangers are more obviously inviting.

DEFENSIVE ELEMENTS* obtained from the local vegetation of every climate: scientific plantation being inexpensive, easily kept in repair, stronger with age, and then less destructible by hostile missiles than regular revetted works.

> "Nervii quo . . . . . . impedirent, teneris arboribus incisis atque inflexis, crebrisque in latitudinem ramis enatis et rubis sentibusque interjectis, effecerant ut instar *muri* hæ sepes munimenta præberent. Quo non modo *non intrari* sed ne perspici quidem possit."—*Cæs. de B. G.* lib. ii.

Officers charged with the defence of a frontier, an island, or a colony, are often unable to carry their projects of fortification into effect on account of the enormous expense they demand when the system is sufficiently enlarged to be really effective. Moreover, Engineers find themselves posted in regions where the materials required for the due execution of their purposes are rare, expensive, or inaccessible, and where the scientific systems, primarily invented for the conditions of European warfare alone, are little applicable; or if they are within this sphere, they may have to submit projects, which, however much they may be appreciated for their importance and utility, are nevertheless inadmissible, because under existing systems of national defence the resources of a kingdom are often scarcely, or not at all, adequate to the expenditure of construction and repairs.

It becomes, therefore, desirable with the departments in charge of this great branch of the Service to devise means both on the great and on the smaller scales for home and for distant regions; which, while they maintain the most approved

* By Colonel Hamilton Smith, K. H.

principles of permanent defence in their integrity, render them nevertheless available in all places, by such modifications as the nature of the soil or the climate will admit, and the elements accessible for the purpose offer, for employment. In all climates, the resources of mountain, hill, rock, ravine, sea, lakes, rivers, and marshes occur; but the best systematic methods for adapting them to defence are not the object of these remarks: they are thoroughly understood by the scientific corps in every Service. Now the use of a method applicable to permanent fortification,—one entailing but a comparatively trifling expense,—kept up in a perfect condition with only the proper supervision of a few well-instructed men, and withal, one under such supervision becoming stronger and stronger with the increase of years,—may be found in the botanical resources of every region more or less fit for the purpose; and it will be proper, at convenient opportunities, to study in each locality what plants should be selected for the differences of soil where they may be wanted.

That the idea of systematic defensive plantation is not new, may be gathered from the motto at the head of this article, taken from Cæsar, and also from our wars in the mountainous parts of India. The proposition therefore is urged mostly on the ground of the vast resources it creates for an Engineer, endowed with a suggestive mind, to adapt available botanical means to the wants and conditions of the problems he has practically to solve.

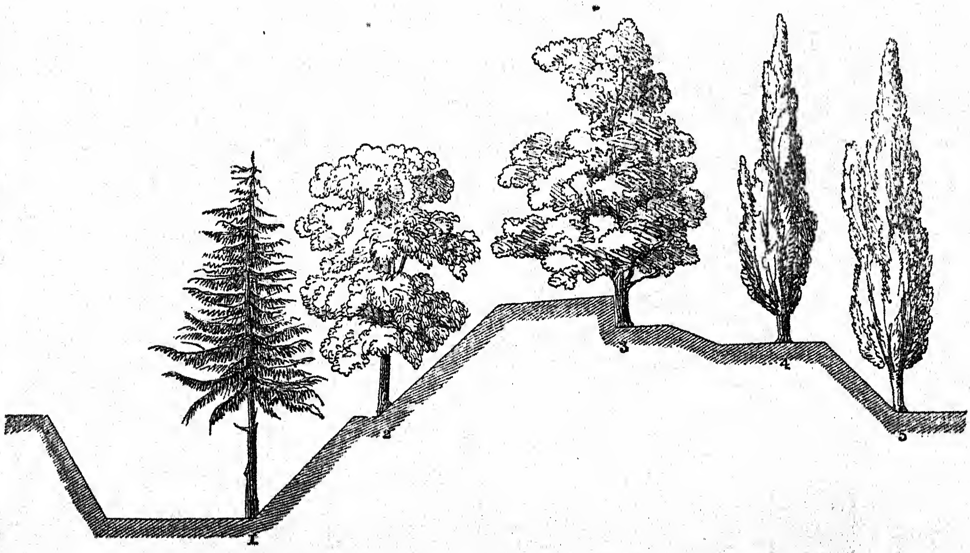
The qualities of trees and plants best adapted for the formation of living, or at least vegetating ramparts, are necessarily,—1st, those which will flourish best in the closest practicable linear juxtaposition; 2nd, those that grow straightest; 3rd, those that have the hardest wood; and, 4th, those that strike the deepest roots. In the tropics alone the Engineer can find evergreen trees with spinous bark; and for covering the front of the approaches, impeding ascent on the rampart, intersecting communications, lining dry ditches, and, above all, rendering escalades and surprises impracticable, the tropics and hot climates again are best provided; though Europe, and even the North, are not deficient in valuable means for effecting the same purpose, provided we remain satisfied with several of the most essential qualities; for all united can seldom, if ever, be found in one species of plant.

In northern and middle Europe the species best adapted are, first, several of the Coniferæ; such as the Swiss pines, the larch, the spruce and juniper pine, the Scots and silver firs, Araucarias and New Zealand pines, &c.; then beech-trees and Lombardy poplar. Where it is desirable to have a rapid growth, the same Lombardy and the small-leaved black poplar; but in the South by far the best is the cypress. Within and on the borders of the tropics, palms of various genera are decidedly the best, because there are species that thrive in salt water, others in marshes, and many on the uplands and even on high mountains. Though they have very little depth of root, they bear very approximate planting, admit easily of palisades between them, and offer the most enduring resistance to cannon-shot. Research and experience will, most assuredly, discover many other trees and improved modes of applying them, but in a general view, where reasoning from a few known facts, we may draw certain inferences to a given extent. Thus it may be asserted with perfect security in truth, that trees in general are but little shattered by cannon-shot, as from personal examination was proved in the parks and plantations of Dresden, in the great avenues along the Pleisse on the south of Leipsig, and in the gardens of M. Reichenbach, both localities long exposed to most terrific cannonades and unceasing musket fire;* and in 1830 the park of Brussels offered the same results.

* It was in this garden Prince Poniatowski perished, and nine Polish battalions with four Generals surrendered after a most determined defence, for they left 600 dead on the spot. The close-set trees in the walks alone rendered the protracted defence possible.

With regard to the trunks of palm-trees, the attack of Mudfort Island, near Philadelphia, in 1777, is a proof that cannon-shot have inadequate effect upon them. Cocoa-trees and other palms will flourish at 4½ feet distance from each other. We have examined a row of cypresses near Marseilles, all from 75 to 80 feet in height, and above 2 feet in diameter, yet not more than 5 feet from each other. In the gardens of M. Reichenbach, already mentioned, several avenues about 16 feet broad were planted with Swiss pines, in some places so closely that it was difficult to pass between them, yet the trees were upwards of 40 feet high, with trunks 18 inches or more in diameter, and literally having the bark on one side riddled with innumerable musket-shots fired into them at the battle of Leipsig, seven years before we examined them. At Neuwied on the Rhine, the *allée* or avenue to the back of the prince's palace is planted with four rows of Lombardy poplars, many of which are estimated at above 100 feet in height, and the trunks at base nearly 5 feet in diameter: the avenue is broad, but the two rows on each side are scarcely 10 feet from each other, or lengthwise from centre to centre of each tree.

Now, supposing a great front of defence, such as a permanently fortified camp destined to hold up the ultimate vitality of a State, be the object under consideration, —and without adverting to the particular system of fortification, as regards the projection the Government may sanction,—we confine our view for the moment to the mere profiles of construction intended for the curtains, and allowing the talus to be about forty-five degrees, in order to give greater stability to the trees, we commence near the foot, at a proper elevation above the water, if the ditch be wet, or at the



foot itself, if it be dry: we plant thereon a row of the class of forest trees appropriate to the nature of the circumstances of the works as well as of climate and soil; a second upon the berm; a third forward on the banquette of the parapet, which, being the most important, should be entirely composed of the best-conditioned plants: we then proceed with a fourth at the edge of the terreplein, and a fifth within the polygon at the foot of the inner slope of the rampart. We shall have

in a few years five rows of trees capable of material use in defence, provided the plants are laterally cleared of branches* as they grow up, and those to the front and rear alone preserved until above 25 feet from the ground. No. 1, the foremost in the *fossé* when a state of siege or attack is apprehended, will be cut down along with that on the berm, No. 2, brought within and employed with No. 5 at the foot of the terreplein, to convert into *palanka*† palisades, in order to fill up the intervals between the living trees of the parapet; to construct *blindages*, bomb-proofs, fraises, and defences for the caponières in the ditch. On the edge of the counterscarp, as also on the crest of the glacis, another row may be planted; and from thence outwards, in quincunx, trees remarkable for striking deep tap-roots, such as Turkey oak, Valonia oak, Ilex, larch, &c. In hot climates, palm-trees, cocoa-trees, date-trees, fan palms, arecas, &c.; some, like the cocoa, growing in salt water; all which, being cut down at the moment before stated, will suffice to palisade the banquette of the glacis, intersect the external roads for rounds, make gates, and, where necessary, fraise the rampart securely, by connecting the fraises with the stumps of the removed trees.‡

The pine, larch, or fir species, may be planted at 3 feet apart; thinning them out eventually is objectionable.

The enemy cannot see what passes within the lines, nor gain much information, nor attempt an escalade by surprise, much less venture to storm works which he cannot previously dismantle with his cannon. By palanka palisades we understand such as could be made from young trees in the rough, standing above ground irregularly from 14 to 18 feet in height: where unsupported by living trees, they should be completed like a common stockade: climbing over them need not be mentioned as practicable, so long as any resistance is offered even by the worst disciplined troops. In confirmation of this observation, it may be stated that the Austrians and Russians were in general successful in storming French redoubts protected by ordinary palisades, but that they never ventured to attack the palanka-defended redoubts at Dresden; nor did General Maison attempt those of the Saxons covering the gates of Tournay, in the beginning of 1814, they being similarly formed.

On the crest of the glacis and the immediate slope before it, as also to cover caponières, hedges of holly (Ilex aquifolium) will make a very difficult obstacle; and in sandy soils the common furze (Ulex Europeus), when occasionally shorn and trimmed, is likewise convertible to impenetrable hindrances; and where and when required, both may be cut down low without losing the defensive property. As from the palisades the defensive troops behind the glacis can view through the lower part of the hedge of the champaign country, and can reach through with the muzzles of their muskets, they can obstinately chicane the outposts, notwithstanding any tirailleur force that may be sent against them, or the grape-shot that may be showered in their direction, because the assailant must be wholly exposed, while the defendants are entirely concealed. Where neither holly nor furze can be procured, hew hedges (Taxus baccata) are likewise very difficult to force, and hornbeam-tree (Carpinus betulus) and blackthorn (Prunus spinosa) may be made to answer in Europe. All these plants require only in the first instance proper selection and preparation of the soil, and subsequently careful trimming and watching.§

* Care must be taken never to lop the branches within one foot of the trunk, as when cut too close, delay frequently commences at those points.—*Ed.*

† See Note, p. 28.

‡ The impediments to Sapping caused by the roots of trees are well known.

§ There are many other available species, and some foreign, that will thrive exceedingly well in Europe, even far to the north, such as the *Carpinus Virginiana*, a quick growing, hard, tall, and very valuable tree; and the Jekoom-tree, in Gujerat, makes excellent defensive hedges.

Such a system would demand in time of peace only a small portion of veterans to guard the works, and among them a certain number trained to trimming and preserving the plantations. When peril threatens, a general requisition of handicraftsmen would in a short time prepare the whole for defence; the resources of the country would take safe shelter behind the lines; and under the command of a few experienced Officers, even a half-trained volunteer population, a landwehr, or a militia, would maintain the position, provided an adequate body of artillery were with it. With the new dangers steam-boat warfare may bring forth, when almost every coast may be threatened with sudden and serious invasion, certain points may be deemed to require such positions of refuge, fit for concentration, more than formerly.

On a minor scale, and of less importance, are the defences required in the colonial and particularly tropical possessions of the nation. Excepting where the French have built and maintain at a vast expense their citadel forts, the extra European systems of fortification are absolutely insufficient. The ardent sun, violent rains, and frequent earthquakes, together with the economical indifference of the colonial legislatures, cause in particular all English defences to fall to ruin. Instancing Jamaica, the two principal fortified points, Port Royal and Fort Augusta, are (or at least during the wars of the French Revolution were) totally indefensible: both their fronts of defence were of masonry, but cracked by earthquakes, undermined by the sea, and filled with sand: the first passable even without a scaling ladder, and the second without ditch, drawbridge, gate, outwork, or glacis. In the one, no guns mounted or fit for service; in the other, most of them taken off the rampart, and the rest drawn back on account of the insecurity of the wall. All the other fortifications in the island were still in a worse condition: no gun-carriages fit for service, and many guns unfit to be loaded.

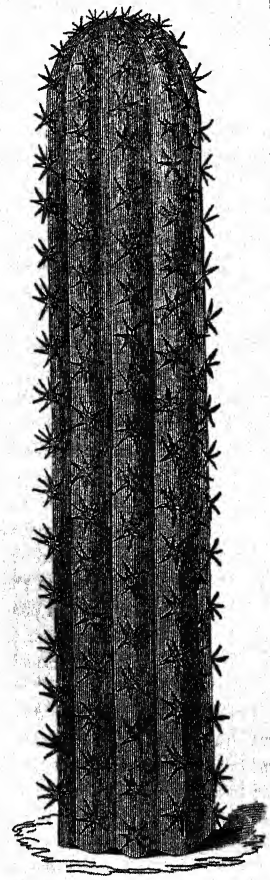
For the defence of all these places positive means exist in the tropics. By the encouragement of the growth of cocoa and mountain cabbage-trees, by the introduction from the Continent of numerous other species of palm, all the sandy and saline lands on the sea-shore may be beneficially and cheaply planted, and in many places they might be arranged in the manner before described so as to form fronts of defence, which, when necessary, would require only the cutting down those that grew beyond the sphere of action, and using them as palisades, &c. Dear-bought experience has taught us the formidable nature of bamboo stockades and bound hedges; it suggests similarly that the bamboo should be encouraged in the West India islands, where we have seen clumps in luxuriant growth reaching to 60 feet in height, both on the plains and in the mountains. Both these vegetable families of plants thrive in poor as well as deep soils, and for outworks the Euphorbiæ, Agaves, Cactus opuntium or Echino cactus, Cactus Ficus Indicus, the aloes, and many other thorny productions, require only the care of protection to be made formidable for defensive purposes.

In Jamaica, during the martial law of 1805, it was exemplified what could be done with the botanical resources for the defence of the forts so defectively constructed as above shewn. Representations from the island Engineer to the island Legislature, recommending a very considerable increase of cocoa-trees, by planting the nuts within the fences of the '*pens*,' (country residences in the plain of Liguana,) and bamboo on the rocky hills, had indeed been received with approbation, but were not put in execution.

But Fort Nugent, at the head of Kingston Harbour, requiring to be placed in a state of defence, advantage was taken of the momentary alarm to cover the front of the whole position in three successive belts, each 9 feet in width, with close-set plants of the Cactus (opuntium) undecimalis, a succulent plant growing abundantly on the spot; and although at first military men thought the element employed of little or no defensive value, as the work increased their opinions changed, and some

years after, when the late General Sir Charles Shipley visited the ground on his tour of inspection, he expressed his unqualified approbation of the use of the plant and the method pursued, although from the short duration of military law the whole system had not been completed. The Opuntium undecimalis was introduced from the Spanish Main, and in Peru grows to 25 feet, and branches out. In Jamaica it generally forms but one upright unbranched stake, about 7 inches in diameter, having eleven ridges and as many right-angled furrows. Upon the ridges are grown burrs or tufts of siliceous spines exceedingly strong and sharp, three or four of each burr being from one to one and a half inch in length. They stand about 3 inches apart, but each alternate ridge has them on the intermediate distance, so that a human finger can scarcely touch the smooth green rind without being painfully wounded. Set in juxtaposition, and temporarily kept in line by stakes and poles, they form a close hedge, impenetrable even to a rat. Musket and cannon-balls make mere holes through them. Being succulent, they cannot be burnt; and when cut down they are still impassable, since the thorny spines strike through a boot sole, and the wound is almost invariably fatal, by producing tetanus or lock-jaw. Such was the case with the only three negro pioneers who, notwithstanding the care taken by them to move and set up the plants with long wooden pitchforks, were pricked in the feet and died. Hedges thus set up 9 feet asunder, the intermediate space was planted with lower choppings, and nearly all grew in the dry sand without further trouble than taking the precaution to have each section or cutting seared by exposure to the air for a few days: this should be done in the shade, and last about twenty to twenty-five days before setting. The hedge pieces were 3 feet long, giving little more than two above ground; the inner pieces only a few inches. Had there been an abundance of bamboo plants, the whole parapets and bound hedges would have been fraised in the Indian manner in the condition described; but there was no likelihood that a hostile force would have dared to attack the position. Prickly pears and even aloes may serve as substitutes, but the Opuntium may be deemed insurmountable, and certainly becomes more and more so with age, provided care be taken to preserve the belts in due order.

Cactus undecimalis, now probably Echino cactus undecimalis.



Such is the theory and the limited practice hitherto given of a system of defence by means of the living vegetable productions of the climate where it may be put in execution.

APPENDIX.

EXPERIMENTS ON THE COMPARATIVE EFFECT OF RIFLE AND MUSKETRY FIRE ON DIFFERENT COLOURS.

Parkhurst Barracks, Isle of Wight, 1800.

Since the decline of defensive armour, the military costume of civilized nations has gradually become, from feudal and heraldic, either national or governmental in all the organized armies of the world. While plate armour was still worn by certain portions of the troops, and generally by the officers, buff or stag skins was the common dress beneath it, and armies were deemed to be sufficiently distinguished from each other by some trifling cross or badge on their ensigns, and by the colour of the scarfs, arm-bands, and feathers. As the inconvenience of raising military forces on the temporary feudal plan began to be felt more and more, there arose a fashion of substituting instead the system of the Italian Condottieri, which permitted individuals of martial reputation to raise, on their private responsibility, bands of various strength, by capitulation or agreement with the State, and to conduct a war for a given number of months or any other stipulated period. These conductors or generals, by subordinate indentures, gave commissions to other adventurers, who raised companies and thus became captains, who not only commanded but clothed and accoutred them according to their own fancies or heraldic pretensions; and as each company had its ensign, that word became synonymous with it in the North of Europe, where enseignee, ancient, feulein, or vaendel, were their constant denominations, till the necessity was felt of marshalling the infantry into more equally divided bodies, increasing from the squad to the company, the battalion, or tersa, up to the regiment, which occasionally reckoned four, six, or more of them, and therefore amounted to what we now would denominate a brigade, or even a division. It was then the fantastic liveries of the ensign bands or companies were laid aside, and uniforms of the same colour were furnished to a whole regiment. We hear in the Swedish wars of yellow, blue, and other regiments; and in the trained bands of London, in 1641–1645, we find red, white, yellow, blue, green, and orange regiments; but it seems that, in England at least, those denominations referred them already solely to the colour of the ensigns, not of the regimental uniforms, which, under the last Stuarts, were already red with slight exceptions. In France and Austria, white had become the predominant uniform of the armies, whilst in Holland, and soon after in Prussia, blue was assumed, and then Russia made green the national military colour.

Under general circumstances, and in battles, when the distance, the smoke of cannon and musketry, partially, at least, concealed contending armies from each other, glaring uniforms may not have caused serious bloodshed; but in the later wars, and the mode of engaging introduced during the French Revolution, where the rifle service is greatly increased, and clouds of skirmishing light infantry cover the front of their forces so far in advance as to be checked only by similar combatants pushed forward by the opposing army, the fire of both parties is commonly guided by individual aim, and good marksmen make considerable havoc. The colour of the uniform becomes therefore a question of importance, particularly where it is of so distinct a nature as to offer a clear object to the marksman. Observation teaches military uniforms to fade from the eye, in proportion as they are neutralized; from red, the most conspicuous, to earthen brown and neutral greys. To the marksmen, white enlarges the object, and is so far deceptive; blue reduces the real magnitude; black and dark green assimilate with blue, and light green has a tendency to appear neutral. The relative distinctiveness of these colours was readily ascertained by the normal

rifle company of the 6th battalion, 60th Regiment, which, after rather severe service in the Helder expedition, returned to the Isle of Wight, and there had, with the sanction of its Colonel, permission to undertake a series of experiments on the comparative effect of rifle fire upon different colours. After some preliminary observations on plain white and on black targets without ring or bull's-eye, and where the first mentioned was evidently more maltreated by rifle shot than the second, it was resolved to confine the trials to plain red, green, and grey,—a light iron-grey made with distemper being then the uniform of a Highland regiment, of a Dutch rifle battalion, both in the same garrison, and the normal company in question, which then still had the same Austrian Tyrolean costume which it had worn in the last Helder expedition. From this company were selected the six best marksmen, all educated *Jäger*, and each was supplied with six bullets. The red target, placed on the open heath, was distant 125 yards from the stand: the time selected was seven in the morning, with weather sufficiently moderate not to have perceptible influence on the direction of the shot; the men were to load as to them seemed best, and to fire at leisure. After each had fired six shots, the party returned home. On the next day, when the weather was equally favourable, and the sun at the same angle of elevation, the same number of shots were delivered by the same men, and under the same conditions, at the green target; and on the third, at the grey.

On the third day of the second series of trials, the men immediately observed that they were now so familiar with the distance, that their fire would be more effective than in the first. But it was this time the grey target that was to be aimed at, and the result turned out by no means commensurate with the expectation of the marksmen. In this manner the second series of experiments was conducted, even with more care, if possible, to maintain the conditions perfectly similar: each day the targets had the shot-holes stopped, and the surface repainted; but now the red target was already so much damaged, that fearing it would not hold together for the day's trial, the distance for the third and last series of rounds was increased to 150 yards, and notwithstanding the changes resulting therefrom, it fell to pieces before the last shot was delivered, and, being bound together by withies, was brought home in a bundle. The green also was so much battered in the fiery ordeal as to be unfit for repairing; but the grey remained sound, and was afterwards used again. There had been fired 108 shots at each, 72 of which at 125, and the last 36 at 150 yards. It is to be regretted that the exact number of shot-holes which had been each day carefully noted down is not now in the possession of the writer; the copy of the Report which was sent up to Sir Robert Brownrigg, the Quarter-Master-General of the forces and Colonel of the battalion, having been lent to a military acquaintance who never returned it. But so far as recollection can be depended on, there were, it is believed, more than double the number in the red than in the grey target, and the state of the green was intermediate. It was observed also that the grey was comparatively unhurt when the distance was increased, and to ascertain the fact more fully, that target was afterwards painted vertically one half red and the other left grey, and the same result was obtained. It was then suggested to set up the triangle stand, upon which the rifle can be laid, in order to level it at the centre, and screw it fast. The most experienced Tyrolean in the company took pains to effect the object, and still the red bore the great majority of hits, upon which last occasion only it is proper to observe that both ring and bull's-eye were painted black, none having been used during the three first series of experiments.

The general result is, however, of so important a nature, that it appears exceedingly desirable they should be repeated, and, if possible, with still greater precautions, because, in case of further confirmation, the question arises whether all riflemen

and light infantry should not take the field in some grey unostentatious uniform, leaving the parade dress for peace and garrison duty.

CHARLES HAMILTON SMITH, Colonel.

DEFENCE OF FORTRESSES.*

THE RECONNOISSANCE OF THE GROUND OUTSIDE THE PLACE.

1. *The Circle of Action.*—The first duty of a Governor, or Officer Commanding, from the moment of his entering upon his functions, is to study everything which concerns the defence of the place which is confided to his care. He will therefore make himself thoroughly acquainted with its topographical situation; its connection with the neighbouring fortresses; with the frontier in general; with the offensive and defensive operations of the armies in the field, and with the part it might have to play in such operations.[a]

2. *Circle of Investment.*—After having gained this preliminary knowledge, the Commandant will apply himself to study, more in detail, the ground which may be included within the circle of investment, *as far as the most favourable situations for the enemy's parks, and their lines of circumvallation.* He will study all the undulations, in order to profit from the advantage they may offer of confining the enemy in choosing his ground of encampment. Whilst he is employed in gaining a familiar knowledge of the ground, he must calculate beforehand the way in which he could most injure the enemy, without exposing his own troops to be cut off in their retreat.

3. *Circle of Attack.*—Within the circle of attack (*which extends from the glacis as far as a circle which will include, in case of siege, the enemy's dépôts, and the tail of their trenches, a distance of nearly* 1100 *yards from the crest of the parapets of the most advanced covered-way*), the Governor, or Commandant, will keep a strict watch to insure that, in conformity with his Instructions, no buildings or establishment whatsoever shall be made which might serve as cover to the enemy.

4. If the fortress should possess the means of covering any of its fronts by inundations, he will make himself acquainted with the time necessary to form them: he will take care that the bâtardeaux and sluices are in a good state, and that the latter can be worked with facility.

THE RECONNOISSANCE OF THE FORTIFICATION.

5. *Of the main Enclosure.*—The Governor, or Officer Commanding, will reconnoitre, in concert with the Commanding Engineer, the enclosure of the fortress, the nature of its fortifications and works which compose it, both as they relate to the defence in general and in detail: he will carefully examine whether the parapets are high enough to cover the men and guns; also if the scarp wall be such as to be

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* Taken from Instructions issued by the French Imperial Minister of War (Carnot), and translated by Colonel Sir Wm. Reid, K.C.B., R.E., with notes by Lieut.-General Sir John Burgoyne.

[a] When the French were in possession of most of the fortresses in Europe, and were thrown on the defensive, it became a great object to stimulate the Governors and garrisons to the most vigorous defences. Hence, he (Carnot) takes a most sanguine view of the resources of the besieged, and the principles inculcated imply a power and means that will rarely exist, and a considerable degree of energy all on one side of the question.

Still the lessons are very valuable as instructions how to apply whatever resources may be available.—J. F. B.

secure against escalades, or an attack by coup-de-main; in fine, whether each of the works be capable of being retrenched, or of being otherwise improved.

6. *The Outworks.*—After having examined the enclosure, the Governor will inspect all the works comprised under the denomination of *outworks*, and which are situated in the ditches of the place, such as ravelins, counterguards, tenailles, &c.: he will study in what degree they aid the defence of the Body of the Place, and the reciprocal defence they give and receive, as well as the peculiar use which may be made of each in the general defence: he will satisfy himself that their interior is well under the fire of the Body of the Place, and that the communications between them and it are secure.* His reconnoissance must include every gate, sally-port, and issue, by which he might be enabled to fall with rapidity on the enemy, whether for the purpose of preventing a passage of the ditch, or of dislodging him from an outwork which he may have gained.[b]

7. *The Covered-way.*—The covered-way will be the object of particular attention: the Governor will examine whether all the branches be directed in such a manner as distinctly to see the surrounding ground; whether the traverses be in a good state; if the banquettes have the proper dimensions; if there be a sufficient number of barriers for sorties, and if they be properly disposed, and sufficiently palisaded.

8. *Advanced Works.*—The advanced works of a place ought to increase its capability for defence. The Governor will consider for what purpose they were constructed; whether they will perform the part for which they were intended; whether their communications be secure and easy; and above all things, whether their interior be properly seen from the Body of the Place, or intermediate works; because in this case they present much greater difficulties to the besiegers in lodging themselves within them, and they facilitate those offensive operations of the besieged (*retours offensifs*) in which the most important part of the defence of fortresses may consist.

9. *Detached Works, Forts, and other Dependencies of the Place.*—The object of these works is in general to see into places where the undulations of the ground would otherwise give cover to the enemy; to occupy a point which commands the fortress; to protect a dyke or sluice which supports an inundation favourable to the defence; or to take in reverse the approaches of the besiegers.

10. *The Reconnoissance of the Interior of the Place.*—He will be equally careful that the streets which serve as a direct communication between the Great Square, or place of general parade (place d'armes), as well as between the military buildings and establishments, and the streets adjoining to the ramparts, shall neither be shut up nor narrowed, without the plans for that purpose having been previously concerted in conjunction with the Military Engineers.

11. He will examine with care the site of all military buildings and establishments; the esplanades, and all other grounds connected with the fortification, so as to be able to judge what relation they bear to the Body of the Place in case of attack, or with the rest of the interior in case of alarm.

He ought also to know the situation and capacity of such public and private buildings as might be converted into use, as well as what casemates and strongly arched cellars or cover there may be, to protect the provisions and to quarter the troops and the sick.

* Or what temporary means can be applied under the different circumstances of a siege to make them so.—*Translator.*

[b] And study how they are to be best secured in those times, of usage or otherwise, against becoming an inlet to the besieger.—J. F. B.

12. He will examine carefully all the water-courses[c] in the interior of the place, the bridges and sluices, the rivers, canals, aqueducts, drains, &c., in order that all the issues by which an enemy might possibly get into the place be perfectly known to him: he will see that the gratings, or other contrivances for closing them, be kept in good order, and he will, personally, take the greatest care that none of the precautions against surprise be ever neglected.

OF THE ARTILLERY AND AMMUNITION.

13. *Of the Artillery and Ammunition.*—The Commandant will draw up, in concert with the Commanding Officers of Artillery and Engineers, the plan for arming the fortress, with the number of pieces of ordnance which may be necessary, and their stores. He is to verify the reports personally, to see that they actually agree with the state of the stores, and whether there be all the necessary compositions and other auxiliaries (*feux d'artifice*) for defending the breaches, the passages of the ditches, and for throwing light on and discovering the approaches of the besiegers.

See Appendix I. & II.

He will concert with these Officers the various positions in which his artillery may be placed in relation to the supposed attacks of an enemy; and he will also determine on the means to be employed to cover it from their fire.

See 'Blindage.'

OF THE ENGINEERS, AND THE MATERIALS RELATING TO THE DEFENCE.

See Appendix II. & III.

14. The Governor will examine, in concert with the Commanding Engineer, the state of the storehouses and materials for the fortifications: he will acquaint himself whether there be in the fortress palisades in sufficient quantity to replace such as may be destroyed; whether there be a sufficient quantity of gabions, fascines, hurdles, beams, planks, round timber, cordage, iron, intrenching tools, miners' and carpenters' tools, nails, chevaux-de-frize,—in short, everything that is requisite for defence.

OF THE PROVISIONS, AND THE OTHER MATTERS BELONGING TO THE COMMISSARIAT.

See Appendix III.

15. The Governor will examine into everything which may concern the subsistence and the health of the garrison and the inhabitants: he will cause reports to be made to him of the grain, and liquor of every description, which he will personally verify: the description and state of the ovens will be inspected, to be assured that they will suffice for the garrison.[d]

16. The quantity and quality of provisions of every description ought to be perfectly known to him, in order that, calculating the force of the garrison and the wants of the place, he may take the necessary measures for keeping them complete, or for sparing them, in order to prolong the defence as much as possible, in case circumstances should not have allowed him to lay in all that may be proper.

17. He will visit the magazines of provisions, that he may know whether everything relating to them be well regulated, and each species of provisions be stowed in

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[c] The French fort at the Retiro (Madrid) was supplied with water by an aqueduct, which being cut off, the only resource of the garrison of 2000 men was a single well, with a rope and bucket; and at the castle of St. Sebastian, the only supply of water, a spring, was exposed to the fire of one of our batteries on the island of Sta. Clara, to the great inconvenience of the garrison.—J. F. B.

[d] He will see that the supply of fresh water is such as cannot be cut off or destroyed by the enemy. —J. F. B.

the most appropriate place. Looking forward to the necessity of placing them in security in case of siege, should the town not contain a sufficient number of casemates, he will take an account of all the buildings, and particularly of cellars, which may serve this purpose, in order, if required, to render them proof against the projectiles of the enemy. This precaution should extend to all the stores and provisions for the siege, to whatever Service they may belong; and a fair division should be made of the bomb-proofs according to the real wants of each branch of the Service, and not to demands often exaggerated.

18. The hospital merits very serious attention; the Governor should examine whether it admits of being 'blinded' (*blindé*),* and if it would be sufficient for the necessities of the garrison during a siege.[e] In case it would not, the Governor will fix on one or more large and commodious buildings for the purpose, in order to cause the necessary work to be commenced for the security of the sick, from the moment the place may be threatened.

RETURNS OF STORES AND MATERIALS; OF PROVISIONS; AND OF ARRANGEMENTS TO PREVENT FIRE.

See Appendix I. II. III. & IV.

19. The Governor will cause returns to be made of everything useful in case of siege, whether it be in the town or surrounding country, that he may be enabled, at the moment of need, to collect whatever may benefit the defence, and to destroy whatever may be hurtful to it by falling into the hands of the enemy.

20. He will cause the inhabitants who ought to remain in the fortress to provision themselves in due time, for a period at least, as long as that for which the garrison is provisioned: he must make them understand the necessity of not waiting till the last moment for supplying themselves with the things they require for their consumption, because they ought to know that their interest, in this respect, is the same with that of the defenders; and that those who are herein guilty of neglect will run the risk of want during the siege, or of being turned out as useless mouths.

OF THOSE PREPARATIONS FOR DEFENCE WHICH BELONG TO THE STATE OF WAR, AND ESPECIALLY ON THE PROSPECT OF A SIEGE.

21. The Governor will accelerate the works of defence by every means in his power.

22. He ought now to commence the inundations, if they are slow in forming themselves, and to fill the reservoirs which are to sweep those ditches which are intended at first to be defended as dry ditches.

See Blanshard's Pontoons, Article 'Bridge.'

23. He should construct bridges of rafts, to communicate across ditches and rivers: such bridges cannot be destroyed by the enemy's artillery, and may be made to bear the heaviest weights.

24. In sea-ports and in fortresses situated on great rivers, or fortresses in front of which wide and deep inundations may be formed, he will collect armed boats. The mode of arming them must be concerted with the Commanding Officers of the Artillery and Engineers, and, when there may be one, with the senior Officer of the Navy.

See Appendix III.

25. The Governor will apply himself, with the greatest diligence, to all that regards the provisions and stores of every species, and he will use all means to make

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* Converted into a temporary bomb-proof by strong timbers.—*Translator.*

[e] And if situated in a position little likely to be exposed to the fire of the besiegers.—J. F. B.

them complete and to keep them so: this is the most delicate part of his duty, and that in which negligence might cause the worst consequences.

If all the grain be not ground, he will cause it to be done, or else satisfy himself that there is the means for grinding it during the siege, by constructing in time either hand-mills, or mills to work by means of horses.[f]

26. Great fortresses alone have the property of having some part of the interior little exposed to the enemy's fire: such an advantage is precious. It is in those parts that it is of consequence to deposit such provisions and stores as are most valuable, avoiding, however, to unite them in mass, that they may not form a focus for conflagration.[g]

Magazines of wood and forage ought to be in the open air, in small isolated stacks. The daily issues can be very well made in sheds.

27. When the town is small, and where there is no quarter that will not be very much exposed to the effect of the enemy's projectiles, the bomb-proof covers must be multiplied as much as possible by means of blinds (*blindages*).[h] Such shelter is formed in a short time, and only requires timber and earth. Buildings having thick walls may be advantageously used for the purpose; they should be blinded on each story if possible, the useless doors and windows should be blocked up, and in this way healthy bomb-proof cover may be obtained for the defenders, and especially for the sick.

See Article 'Blindage.'

See Appendix II.

See Article 'Blindage.'

28. If there should be neither building fit for blinding, nor yet bomb-proofs, in a fortress, their place may be supplied by forming blinds, of trees leaning against each other in a sloping position, or being placed inclined against revetments or solid walls in those parts which are the least exposed.

29. The same measures should be adopted for the powder magazines if they are not already bomb-proof. Such as exist ought to be solidly blinded; and if they should not suffice, then dry cellars must be occupied and blinded.

30. The wells and cisterns which may be necessary for a supply of water must be also blinded.

31. After these details it will be seen how necessary timber is in a fortress. Therefore the Governor must neglect no means of augmenting his store of that useful article.[i] It is also required for retrenchments, for wooden tambours, for fraises and

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[f] British troops are accustomed to the use of sea biscuit, which forms an admirable article for lengthened storage. The French seem to have an objection to it.—J. F. B.

[g] It is peculiarly necessary to have the magazines for ammunition well subdivided, so that an accident to any one should not be fatal to the place: the principal magazine should never be resorted to for ordinary daily consumption, but the smaller magazines kept supplied from it at particular and rare times, when that service is least likely to lead to danger.—J. F. B.

[h] It must be observed that an arch constructed as bomb-proof, and even so much so as to resist *any one* shell that can fall upon it, is not to be considered as affording absolute security. For an arch may not resist a *number* of heavy shells falling upon it: this may happen accidentally when the bombardment is heavy or when the building is seen from without; or, its position well known, it may be battered as it were by vertical fire, as well as an ordinary wall is by horizontal fire; and this has been done frequently against principal magazines, and with success.

A kind of barrel has been adopted in the Navy that has a door or available opening, and is perfectly secure against water or damp: it is suggested that barrels large and small, on that principle, might be constructed, without any great increase of expense, that would be very useful for damp places or magazines for the land service.

See Article 'Coast Defences.'

It will be remarked that many of these wants are created by imperfections in the fortress; most of them should be permanently provided for in the original construction, and only those required at the period of the siege as are dependent on the operations of the besiegers, and consequently could not previously be regulated without an excess of expense, by providing for *every part* means that may be only wanted on one.—J. F. B.

See 'Defensive Elements.'

[i] The advantage arising from planting the ramparts and open spaces within fortresses has been always admitted, and yet it is not always practised.—J. F. B.

palisades, for repairing damaged gun-carriages, for constructing rafts, &c., and for the consumption of the garrison.*

32. If the front of attack be determined by the nature of the ground, the Governor will cause the bastions to be retrenched beforehand. He will form cuts in the outworks if they will admit of it, and he will cause a supply of gabions, fascines, sand-bags, and palisades to be carried to them, that he may be able to retrench and defend the breaches, and he will construct such traverses as may be necessary.

33. Should the front of attack not be absolutely determined by the circumstances of the place, the knowledge of the fortress which he will have acquired ought to enable him to judge which side the enemy will choose in preference. There he ought to prepare the means of defence, that he may be able to execute the works which may be required, as soon as the operations of the enemy shall have shewn his real designs.

See Article 'Boom.'

34. In fortresses situated on rivers, stockades or barricades should be made where they enter and where they issue, in order that nothing may possibly insinuate itself into the place. They must be moveable where there is a power to send out armed boats to outflank the enemy's attack when the banks will admit of it, or for other purposes.

See Appendix I.

35. The Governor will cause the first disposition of the artillery against the beginning of the enemy's approaches (and which will have been previously concerted) to be carried into execution, as well as the armament of batteries of which the position is fixed, such as those of cavaliers, of flanks, of works covered by inundations, &c.; but all others ought to be established successively, according to the progress of the attack.

The point of importance therefore is not that batteries should be made beforehand, which may remain for a long time or for ever useless, but that the nature and effects of the different species of ordnance of all calibres should be well understood, in order to determine in what way they shall be employed during the various circumstances which arise in a siege.

See Plate of 'Defence of Fortresses.'

Above all, the very oblique fire (*feu d'écharpe*) must not be neglected, by establishing batteries on those works which are collateral to the front of attack.

OF THE STATE OF SIEGE, DIVIDED INTO FIVE HEADS; AND TREATING OF IRREGULAR ATTACKS, WHICH MAY PLACE A FORTRESS SUDDENLY IN A STATE OF SIEGE.

FIRST HEAD.

36. *Of Surprises by the Enemy, or by revolted Inhabitants.*—The Governor, responsible for the place confided to his care, ought to neglect nothing to prevent surprises, and should take the most minute precautions against their recurrence. The following measures should be adopted: to repair every part of the rampart by which an enemy might insinuate himself into the place; putting double gratings to the drains or aqueducts, and placing sentries to watch them; and always to have at hand, at the point of danger, detachments which may be brought up rapidly. He should likewise shut up all the embrasures or openings that may be too low.

37. If there should be no drawbridges in front of the gates, palisades or advanced

* An order was issued in 1795 to plant the glacis of every French fortress with trees, for reasons which are given at length in the 155th paragraph of St. Paul's 'Traité Complet.'

At the siege of St. Sebastian, when attacked by the English in 1813, the trunk of a large poplar-tree completely stopped the progress of the Sappers, and defied all their efforts to move it, until one of them gallantly jumped from the trench, and stood exposed until he moved it from the head of the Sap, and returned without being wounded.—*Translator.*

barriers should be constructed, and warders posted in them for the purpose of stopping strangers and examining waggons.

All openings caused by rivers should be shut in a similar manner; and all boats carefully searched.

Before the gates are opened, some soldiers should patrol and search all places where an enemy could conceal himself.

Persons waiting at the gates for admittance should be examined; loaded waggons should be forced to keep off to a distance, and should be probed; the second gate should not be opened until the first is closed and the drawbridge raised; the guard should be under arms inside the gate; waggons should be admitted only one by one, and never be suffered to halt between the gates; care should be taken that the portcullis be in a proper working state (if one exist), and that the mode of using it be explained by the old guard to the new at the time of relief.

38. In time of frost, the ice in the ditch must be broken every day. In such a case, when a channel has been made in the middle of the ice, a boat* should be continually dragged up and down, which, by its motion, will prevent its connecting itself again.

39. There should be no remission of the precautions in very wet or inclement weather, and in fogs they should be doubled; the approaches to the counterscarps watched, by posting a sufficient number of sentinels and small parties in the covered-way, so as to prevent an enemy's being able to pass between two of them, or to enter it without being seen.

40. To protect himself against revolts in the interior, he must establish a severe police, and study well the character of the inhabitants; and if he has reason to fear them, they must be disarmed: and he must take measures of precaution in time, such as to fortify the guard-houses and selected strong buildings against the town, to have artillery ready to occupy all the streets leading to the spots most favourable for large assemblies, and to secure the avenues of the citadel or keep, in which the service must be performed in the strictest manner to prevent surprises.

SECOND HEAD.

41. *Of Escalades.*—Everything which has been stated in the preceding paragraph relating to surprise applies to this; because, if proper precautions have been taken, it will be difficult, if not impossible, for the enemy to get into the ditches of the place and to plant ladders without being discovered, or without the garrison having timely notice of the design, and being in a state to defeat it.[k]

THIRD HEAD.

42. *Of Attacks by sudden Assault.*—Attacks by sudden assault, or accelerated sieges (*siége brusqués*), are, properly speaking, a species of surprise against which the vigilance and precaution recommended in the preceding paragraphs are the most effectual preservatives. Nevertheless it may occur that the enemy, pretending to besiege the place regularly, may happen to accelerate the approaches against one of the fronts of the fortress: it is necessary in such a case to fall upon him vigorously, and to leave nothing undone to drive him from the works of which he may have taken possession.

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* Carried into effect by General Rapp at the Siege of Dantzig, 1813.—*Ed.*

[k] Against escalades and accelerated assaults in general, the most essential means of defence is in a flanking fire; it is far better to make that efficient than to disseminate the forces all along the lines.—J. F. B.

43. One may suspect his intention if he does not make his attacks on that side of the place where he ought naturally to do so, in order to take it in the easiest way.

In such case the watchfulness on that side ought to be doubled.

44. In general it should be considered necessary to watch every front of the fortress.[1] Even when it is evident from the works of the enemy, which is his point of attack, the other sides must not be neglected; but it becomes more particularly so when there is a point which is admitted to be accessible, that it is of importance to take every precaution against sudden assault, and to do all that is possible beforehand to render it secure.

FOURTH HEAD.

See Article 'Bombardment.'

See 'Defence of Coasts.'

45. *Of Bombardments.*—Simple or irregular bombardment may be either effected by a corps of an army, which is too weak to invest a place, planting mortars hastily opposite to one of its fronts; or by bomb-ships, if the place be a sea-port. The Governor ought in such case to try and destroy the land batteries by sorties, or to burn the squadron. In either case he should multiply the number of guns on the faces which see the line of the enemy's fire.

46. Against such attempt the Governor should cause the ammunition and provisions to be placed in casemates or under bomb-proof blinds; or at least to place them in the parts of the town the least exposed to the enemy's fire.

47. He ought to establish measures for maintaining tranquillity amongst the inhabitants, and to take every precaution against fire. A well-arranged organization renders the effect of incendiary projectiles less likely to be very serious: sentinels taken from the companies of firemen (*pompiers et gardes-feu*) watch the fall of shells or the direction of red-hot shot; those on guard, furnished with buckets, run to the spots where fire shews itself, and put it out at its commencement. They follow the red-hot shot, throw water into the holes which they have made, seize hold of them with pincers, and carry them away in metal spoons or vessels to the nearest reservoir of water. By following this system there is less reason to fear extensive fires breaking out; and as the inhabitants themselves are interested in establishing the strictest watch, the enemy will probably not succeed in destroying the town, and he will have consumed his ammunition in vain. All examples prove that this mode of attacking places, at the same time that it does not destroy the fortifications, causes little loss to the besieged.

FIFTH HEAD.

See Article 'Blockade, Military.'

48. *Of Blockades.*—It sometimes happens that the enemy being unprovided with the means required for undertaking all the works of a siege, and supposing the place to be badly provisioned, confines himself to closely blockading it, by seizing all the avenues, in order to prevent the arrival of any succour, and to force it to surrender by famine.

49. The dispositions to be made in this case are, to send away all useless mouths; to cause all the means of subsistence which the environs of the place may furnish to be brought into the town; to use the strictest economy in the distribution of provisions, and to watch the consumption of those of the inhabitants, that they may make them serve whilst the fortress holds out to the last extremity.

[1] The parts of a fortress not connected with that which is absolutely attacked should be placed in divisions, each under a distinct charge, the Officer appointed to which will study the locality, and take every precaution, with as much consideration and energy as if certain that some effort would be made against him: if such arrangement had been made, it is very possible that neither of the assaults that actually carried Badajos in 1812 could have succeeded.—J. F. B.

50. If to a blockade the enemy should join a bombardment, the precautions recommended in the preceding paragraph against fire, and for the security of the provisions and ammunition, ought to be made use of. As to the defence in these two cases, it should be external.

OF SIEGES, OR REGULAR ATTACKS.—FIRST HEAD.

51. *From the Period of Investment to the Opening of the Trenches.—Lines of Circumvallation, Countervallation, &c.*—The presence of an enemy's army within three days' march of a fortress places it in a state of siege. The Governor being previously informed of the projects of the enemy, ought to have everything prepared for resisting a regular attack as long as possible.

52. As soon as the enemy approaches to invest the place, the Governor finishes his first preparations with all possible activity; he occupies such advanced posts as may have their communications with the fortress secure; he sends patrols in every direction to get information of the enemy's movements, and to find out, as well as they can, his force, his projects, and his means of executing them.

53. The investment being effected, the enemy's camp will be drawn on the plan of the place, according to which the Governor, in concert with the Commanding Officers of Artillery and Engineers, will regulate his arrangements for the defence in proportion to the enemy's progress.

See 'Attack,' p. 91.

54. If the garrison be strong, some sorties may be hazarded; but it is seldom that sorties at such a distance succeed, unless it be in consequence of the fault of the besiegers in neglecting the ordinary precautions. They are besides very fatiguing for the garrison, which it is more advantageous to employ in executing the pressing works always required in a defence.

55. At night he will send out small parties in opposite directions, who will creep along, taking advantage of banks or uneven ground, and proceed in silence as far in advance as possible; then, lying flat on the ground, they will listen with attention to the smallest noise; they will afterwards retire on the fortress in extended but connected order, to try to surprise Officers who may be out to reconnoitre the place. These parties must agree on a signal that they may know each other.

See 'Defensive Precautions.'

56. In the first moments the Governor may employ his good marksmen advantageously.[m] Wall-pieces should be placed on the most elevated situations, and he should mix some of the marksmen with the parties sent outside the place, with orders to fire on those who may be attempting to reconnoitre the fortress.

57. It is at nightfall that these marksmen, &c. ought to watch with the greatest attention; that being the period for reconnoitring, tracing, and pushing forward the attacks.

SECOND HEAD.

58. *From the Opening of the Trenches to the Crowning of the Covered-way.*—As soon as it is known in what direction the enemy is opening the trenches, the Governor should cause embrasures to be opened, and platforms to be laid for the guns; double rows of palisades to be planted in the covered-way; useful temporary works of fortification to be made, such as flèches at the foot of the salient angles of the glacis. These flèches, made capable of resisting a coup-de-main, retard considerably (as is well known) the commencement of the third period of the siege, which is the most

[m] Field-pieces and wall-pieces should be placed in the most commanding positions, and fired, without sparing, against the reconnoitrers, whether in bodies or single.—J. F. B.

See Appendix V. important: he should have mines under the glacis, to be prepared with diligence; bridges of communication, to be promptly established, for which timber ought to have been prepared beforehand, and placed in store; and the retrenchments of the outworks, and of the bastions, should proceed with the greatest activity. If these retrenchments are not ready made, and have not revetted scarps, they should be as solid as earth and fascines can make them, and according to plans which should be well digested long before.

The same applies to redoubts in the salient and re-entering places of arms.

59. If there be no caponières communicating between the place and its outworks, the Governor should cause them to be made.

60. When the enemy shall have forced the outposts to fall back, the Governor ought to keep his garrison as much as possible behind the advanced works, and to preserve for himself, as long as he can, the attitude and energy of the offensive. The garrison, posted thus, is in the best possible condition for sorties.

They should be at one time great sorties, at another time petty ones; sometimes false, and often real.

The Governor's object ought to be to torment and harass the enemy, and to keep him continually on the alarm, which will cause him to lose as many men by fatigue as by fighting.

Sorties have always the effect of interrupting the enemy's works, and of dispersing the workmen. In the confusion and obscurity of night it is difficult to assemble them again and to set them to work.

In serious sorties there should always be working parties to destroy and fill in the trenches, and some draft-horses to carry off cannon which may be taken.

See Appendix V. 61. As the works of the enemy advance, the Governor ought to endeavour to outflank the attacks, either by armed boats (in places situate on rivers or on the sea) or by pushing out lines of counter-approach.

These lines are a species of trenches which run out from the covered-way on the right and left of the attacks, to enfilade the works of the enemy. They ought to be applied with circumspection: destined to outflank the enemy's trenches, they should not be enfiladed themselves. They ought therefore to be adapted to the nature of the ground, in such a manner that their prolongation shall fall on hollows, rivers, ravines, or in marshes, beyond which cannon cannot act against them with effect; and that they shall terminate, if possible, upon some inaccessible piece of ground, that the enemy may not have it in his power to cut them across by a boyau from his trenches, or to envelope them in an attack.

62. Good marksmen* may also be sent out a little before daybreak, who should place themselves flat upon the ground on the prolongation of the advanced trenches.

If there be any light artillery, some pieces of small calibre may also sometimes join these marksmen.

See Appendix V. and articles 'Fougass' and 'Military Mine.' 63. When, in spite of the efforts of the besieged to retard the advance of the attack, the enemy shall have arrived on the glacis, the Governor will employ all the resources of subterraneous warfare, which may either form part of the fortifications or which he may himself have contrived.

A well-directed fire crushes the heads of Saps; the marksmen posted in the covered-way retard the progress of the works; small sorties upset them.

64. When the enemy's works are destroyed by mines, the besieged should take advantage of the disorder of the enemy, and upset as much as they can of his works.

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* See 'Defensive Precautions.'

65. If the besiegers decide to assault the covered-way, the salient parts, which are under the protection of the fortress and its outworks, should be defended as long as possible.

66. If the enemy be most decidedly superior, the salients should be abandoned to him, and the re-entering places of arms firmly maintained. The enemy should be left for a while exposed to shells, grenades, and stones; after which, the besieged should debouch from the re-entering places of arms, not only of the fronts attacked, but from the adjacent fronts, to drive him back and to destroy his lodgements.

67. If he decide on crowning the glacis step by step, the progress of his Saps becomes slow and deadly: in order to drive the defenders from the salients, he must construct trench cavaliers, the formation of which is long and perilous; or powerful batteries, which are difficult to erect, under the close fire of the place. After which, in carrying his lodgement along the crest of the glacis, he must successively drive the besieged from each traverse: master of the branches, he has to attack the re-entering places of arms and their redoubts; and it is only by sacrificing a number of men, and by surrounding himself with traverses, that he can protect himself from the reverse fire of the outworks, and make himself master of the covered-way.

See 'Sapping.'

THIRD HEAD.

68. *From the Crowning of the Covered-way until the Assault.*—After the capture of the covered-way, the besiegers endeavour to establish their breaching batteries; their construction is retarded by deadly projectiles; they are counter-battered by very oblique batteries (*en écharpe*) which force them to the construction of reverse traverses.

69. The breach being made in the ravelin, the enemy commences his passage of the ditch. He must make epaulements; or if the ditch be full of water, he must make a bridge of fascines to arrive at the work. The besieged oppose this dangerous operation by all the means which are left them; they overthrow the bridge and the epaulements by their batteries, disperse the workmen by their stone mortars, their howitzers, and their hand-grenades; and (if they have any) they bring forward their armed boats, until this period kept behind the tenailles, to open a destructive fire on the passage of the ditch.

70. If the nature and construction of the sluices will admit of it, they suddenly open them, overthrow the bridge, and sweep it away.

71. If the ditches be dry, they assemble sorties behind their caponières and tenailles, march rapidly on the works of the passage of the ditch, and with hooks drag down whatever it may be composed of, hastily setting fire to the fascines or other combustible materials of which it may be formed.

See article 'Fougass.'

72. The Governor endeavours to clear the breach as it is made, in order to render it less practicable; he prepares fougasses under it; he buries shells and boxes of combustibles in it; he then forms abattis, plants palisades, chevaux-de-frize, and prepares vigorously to dispute it with the besieger when he shall assault it. Here the whole energy of the besieged should be displayed. They have no longer to withstand the whole of the enemy's artillery, which must cease firing on the breach, when the besiegers are ascending it, whilst their own fires incessantly upon the narrow defile by which the assailants arrive at it.

73. It is for the Governor firmly to convince his garrison that the most dangerous operation for the besiegers, and that most likely to cause his defeat, is the assault.

74. Such are the obstacles the enemy ought to meet with, in possessing himself of the breach of the ravelin, which he may besides find defended by a cut yet to be

disputed. If this ravelin has a redoubt, a new operation has to be commenced, a new breach made, a new passage of the ditch, and another assault to be given; for a Governor cannot be supposed to give up a work without having defended it to the last extremity.

75. Master of the outworks, at the expense of so much time and blood, the enemy has immediately to re-commence a new and more dangerous attack against the Body of the Place, to make a passage of the ditch longer than the former, more bloody, and easier to be destroyed.

76. The Governor should have some resolute men to clear the earth from the breaches: this operation retards the assault, which can only be given when they are practicable.

77. With a garrison which is well disposed, a Governor may undertake works of the most extensive nature during a siege, and even under the enemy's fire.

78. After having long disputed the passage of the ditch, he must stand the assault of the Body of the Place.

79. The Governor's duty is to make use of every effort to defend the place to the last extremity; and it is not until he shall have expended every resource, and when it shall be out of his power to repair his last retrenchments, on the point of falling, that he may consent to surrender.

See Appendix II.

APPENDIX I.

PROPORTION OF ARTILLERY NECESSARY.

The quantity of ordnance, and relative proportion of artillerymen, carriages, ammunition, and stores, necessary for the defence of a place, are detailed below; but attention will of course be needed to suit particular circumstances, which may be done by the Artillery Officer employed in the armament of fortresses, who may modify them according to local circumstances, having in view that they do not apply to the sea fronts of maritime places, the armament of which will be found in the article 'Defence of Coasts.'

It is necessary to observe that some rule* must be established to provide for the probable wants of the Artillery; in like cases, that Service forming the most important means of resistance in the defence of places; and hitherto there is no sufficient authority to quote; therefore the principles given in the article 'Artillery,' Section V., will be followed, of having 10 per bastion for the immediate security of the fortress.

And providing for those of the first class 110 pieces,
second „ 70 „
third „ 30 „

in the proportion of heavy guns $\frac{5}{10}$, howitzers $\frac{1}{10}$, mortars $\frac{3}{10}$, and field-pieces $\frac{1}{10}$, consisting of the following calibre:

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* The determination of a Unit for defence has been a subject of some discussion, in which different propositions, such as—A The strength of the garrison,
B The number of pieces of ordnance,
C The number of fronts,

have been made, but they are virtually the same thing, being, *cæteris paribus*, proportional to each other. Hence, for the sake of clearness, general convenience, and consistency,

In Appendix I., for the Artillery Service, B is assumed.
In No. II. (Engineer) the same 'convenience' requires a reference to A B C forms of unit.
In Nos. III. IV. (Provisionment) unit A.

	a	*a*	*b*
Guns .	32-pr.	24-pr.	18-pr. and field-pieces,
	a	*b*	
Howitzers	10	$6\frac{1}{2}$ inch,	
	a	*b*	*b*
Mortars	13	8	$6\frac{1}{2}$

—*a* being for immediate security, and those marked *b* as necessary to sustain a siege; the number of artillerymen being—

7 rank and file for each heavy gun.
6 „ howitzer.
5 „ mortar.
8 „ field-piece.

To which, during the siege, an equal number of men of the Line should be added to assist in the Artillery duties.

The number of carriages—

One traversing platform for each salient angle of bastion.

One carriage + $\frac{1}{3}$ for each gun and howitzer, allowing garrison carriages for those mounted in the flanks and those mounted for the security of the place; and travelling carriages for the guns in store to be mounted after the investment.

One mortar bed + $\frac{1}{10}$ for each mortar, with sling carts and platform for mortars.

The *quantity of ammunition* required should be regulated by the description of fortress; those of the

1st class having 700 shot and 500 shells.
2nd „ 600 „ 400 „ } rounds per piece;
3rd „ 500 „ 300 „

and the *artillery stores* to be supplied in reference to those quantities, as shewn in the annexed Tables A. and B., for each gun, howitzer, or mortar, exclusive of field-pieces; for which see 'Equipment of Field Artillery.'

TABLE A.—Appendix I.

Proportion of the principal Artillery Stores necessary to sustain a Siege.

STORES.	Number per piece. Guns.	Howitzers.	Mortars.
Blocks, Carts, } hand or trench	$\frac{1}{20}$	$\frac{1}{20}$	$\frac{1}{20}$
Carriage, devil	$\frac{1}{20}$	$\frac{1}{20}$	$\frac{1}{20}$
Cartouches, leather, large	1	1	1
Clippers, portfire	1	1	1
Flints, musket *	10	10	–
Gyns, large, complete	$\frac{1}{20}$	$\frac{1}{20}$	$\frac{1}{20}$
Handspikes, common	6	4	4
Handspikes, roller for every traversing platform	2	–	–
Hand crow-levers, 6 feet, Iron crows, $5\frac{1}{2}$ feet, } a small proportion to each battery	–	–	–
Hammers, small claw	1	1	1
Heads, rammer	1	1	1
Heads, sponge	1	1	1
Horns, powder	1	1	1

* When detonating locks are not supplied.

TABLE A.—*continued.*

STORES.	Number per piece. Guns.	Howitzers.	Mortars.
Hambro' line, skeins	$\frac{1}{2}$	$\frac{1}{2}$	–
Iron, {flat, round,} lbs.	10	–	–
Irons, priming, long (sets)	1	1	1
Linstocks, with cocks	1	1	–
Ladles, copper, with staves	1	–	–
Locks, detonating, with laniards and covers	1	1	1
Punches for vents	1	1	1
Ropes, fathoms (to correspond with blocks)	2	1	–
Ropes, drag or harness, 1 to 10 pieces	$\frac{1}{10}$	$\frac{1}{10}$	$\frac{1}{10}$
Spikes, common	2	2	1
Staves, sponge, spare	1	1	1
Sponges, with staves complete*	2	2	2
Spun-yarn, lbs.	1	1	1
Screw jacks	$\frac{1}{10}$	$\frac{1}{20}$	–
Tampions	–	–	1
Thread, pack, lbs.	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Tools, armourers' or forge, sets	$\frac{1}{50}$	–	–
Tools, collar-makers', sets	$\frac{1}{100}$	–	–
Tools, intrenching, sets	1	1	1
Tools, laboratory, sets	$\frac{1}{20}$	$\frac{1}{20}$	$\frac{1}{20}$
Tools, wheelers', sets	$\frac{1}{60}$	–	–
Wadhooks, with staves	1	–	–
Waggons, Flanders	$\frac{1}{10}$	–	–
Waggons, sling	$\frac{1}{20}$	$\frac{1}{20}$	$\frac{1}{20}$
Wads, junk	700	–	–
Wood, {felloes, spokes,} spare No.	4	4	–
Wood, oak, cubic feet	2	2	2

See 'Block.'

TABLE B.—APPENDIX I.

Proportion of principal Laboratory Stores for the Armament of Places.

STORES.	Number per piece. Guns.	Howitzers.	Mortars.
Shot, round	600	–	–
Shot, case, common	70	70	–
Shot, case, spherical	100	100	–
Shot, grape	100	–	–
Shot, pound (rounds)	–	–	100
Wooden bottoms for pound shot	–	–	100
Carcasses, round, fixed	–	–	10
Cartridges, charge flannel, or paper with flannel bottoms	600	400	–
Cartridges, bursters, flannel, common	–	70	–
Cartridges, bursters, flannel, spherical	100	100	–
Valenciennes composition (if necessary) at discretion	–	–	–

* The like number of rammers with staves must now be demanded.

TABLE B.—*continued.*

STORES.		Number per piece. Guns.	Howitzers.	Mortars.
Gunpowder,	large grain, whole barrels	50	30	20
	fine grain, lbs.	10	10	–
	mealed, lbs. (if necessary) at discretion	–	–	–
Shells, common, empty		–	500	400
Fuzes,	common shells	–	600	500
	spherical case-shot, cut C ·3	50	50	–
	spherical case-shot, cut D ·4	50	50	–
	spherical case-shot, cut E ·5	50	50	–
	spherical case-shot, uncut	50	50	–
Portfires		60	60	60
Tubes, detonating		1000	800	700
Match,	slow, yards	50	50	50
	quick, lengths, at discretion	–	–	–
Augers, fuze		$\frac{1}{10}$	$\frac{1}{10}$	–
Barrels, budge		–	–	$\frac{1}{5}$
Boxes, tin, with straps, for fuzes	black	$\frac{1}{10}$	$\frac{1}{10}$	–
	blue	$\frac{1}{10}$	$\frac{1}{10}$	–
Boxes, tube, or pockets, leather		$\frac{1}{10}$	$\frac{1}{10}$	$\frac{1}{10}$
Bags, canvas, with straps for fuzes	striped	$\frac{1}{10}$	$\frac{1}{10}$	–
	yellow	$\frac{1}{10}$	$\frac{1}{10}$	–
Compasses, pairs		–	$\frac{1}{10}$	$\frac{1}{10}$
Engines for drawing fuzes		–	$\frac{1}{20}$	$\frac{1}{20}$
Files, square		1	1	1
Funnels for	shells	–	–	$\frac{1}{10}$
	loading mortars	–	–	$\frac{1}{5}$
Hooks,	hand, pairs	–	$\frac{1}{10}$	$\frac{1}{10}$
	beam	–	$\frac{1}{10}$	$\frac{1}{10}$
Knives, cutting		1	1	1
Measures, copper, for powder, sets		–	$\frac{1}{10}$	$\frac{1}{10}$
Perpendiculars		–	1	1
Pincers, fuze, iron, pairs		1	1	1
Plummets, lead		–	–	1
Quadrants, brass		–	$\frac{1}{5}$	$\frac{1}{2}$
Diagonal scales		–	1	1
Saws, tenon		–	$\frac{1}{3}$	$\frac{1}{3}$
Scales, copper, with beams, pairs		–	–	$\frac{1}{5}$
Scrapers for shells		–	1	1
Screws for drawing corks		1	1	1
Sticks, portfire		2	2	2
Sheep skins		–	–	1
Thumbstalls		–	–	1
Tongs for placing shells*		–	1	–
Weights, brass, 4 lb. piles		–	–	$\frac{1}{4}$
Worsted, ozs.		1	1	–
Wadmilltilts		$\frac{1}{20}$	–	–
Rockets,	signal	1	–	–
	parachute	1	–	–
Blue-lights		5	–	–
Light-balls		–	–	30

* The apparatus for carrying and handling hot shot forms part of the furnace equipment.

TABLE B.—*continued.*

Laboratory materials,	Antimony	lbs.	According to circumstances, as in addition to the fireworks already enumerated.
	Saltpêtre	lbs.	
	Sulphur	lbs.	
	B^k. Dg^d. charcoal	lbs.	
	Isinglass	lbs.	
	Vinegar	gal.	
	Spirits of wine	gal.	
	3, 4, 5, and 6-strand cotton	lbs.	
	Red orpiment	lbs.	
	Cartridge paper	quires	
	Resin	lbs.	
	Bees'-wax	lbs.	
	Tallow	lbs.	
	Pitch	lbs.	
	Turpentine, spirits	gal.	
	Linseed oil	gal.	

The Application of the foregoing Principle to the Defence of Places.

Taking the octagon of Vauban as the example, it has been shewn, in article 'Artillery,' that the number and nature of ordnance required for that description of fortress are—

Eight 32-pounder guns for the salients of bastions	75 guns.
Forty 24-pounder guns for the flanks	
Twenty-seven 18-pounder guns for counter-batteries	
Eight 10-inch howitzers for salients of ravelins	15 howitzers.
Seven $6\frac{1}{2}$ or 32-pounder howitzers for counter-batteries	
Twenty-four 13-inch mortars for the bastions	45 mortars.
Eleven 8-inch mortars for the outworks	
Ten $6\frac{1}{2}$ mortars for the covert-way	
Field-pieces for sorties, &c.	15
Total	150

To this provision may be added a certain number of light and heavy rockets, say three of each to every piece of ordnance.

The number of artillerymen assigned to each piece for the octagon will be as before proposed to each piece.

75 heavy guns	× 7 =	525	artillerymen.
15 howitzers	× 6 =	90	„
45 mortars	× 5 =	225	„
15 field-pieces	× 8 =	120	„
Total		960	rank and file:

an apparently large number, but when divided into three reliefs it will be found inadequate, and men of the Line will be required to be attached to the Artillery, to the extent of as many more, to assist in the various duties of that Service. (See Appendix IV.)

The quantity of ammunition required for the defence of an octagon will be found to exceed 3000 barrels of 90 lbs. each.

This arrangement in the application of artillery is without reference to the duration of the defence, which is contingent on circumstances which are not to

be foreseen; therefore the maximum quantity is given for that fortress, and provided for in Tables A. and B.

The *Artillery operations* in the defence of fortresses usually commence on the investment, when the fire of the guns and howitzers mounted in the salients, and the mortars in the bastions, should endeavour to destroy the besiegers' *dépôts, parks,* and *encampments;* and at this period the heavy rockets should keep up a constant fire during the night for those objects.

The second and most important period in the artillery operations is from the opening of the trenches until the besiegers' artillery has full play, which period may possibly be protracted from forty-eight hours to a week under favourable circumstances by destroying the besiegers' batteries and dismounting their guns; for during this time the artillery of the place is paramount and undisturbed by the fire of musketry or guns.

See Plate, Defence of Fortresses.

The Plate shewing the distribution of artillery for the defence of places will give an idea of the power of an octagon fully armed, which, if used with vigour and activity, will take some time to be overpowered; and as the position of the enemy's batteries is certain, during their construction the whole force of the artillery of the place and the light rockets should be used, and the latter being laid and fired from the crest of the glacis, a constant fire may be kept up so long as the covert-way is tenable.

The next period in the artillery operations for the defence is after the fire of the besiegers' batteries is in full force; for notwithstanding the immense resources of the place, that will eventually occur, and the guns be dismounted and parapets destroyed; then the ordnance in the salients and the covert-way should be withdrawn and placed in the collateral fronts, the dismounted pieces removed and everything made snug, and the ammunition economized for the last effort,—the attempt to destroy the breaching batteries and impede the final advance of the besieger by a new disposition of the flank defences and the employment of the heavy mortars as pierriers.

It is not necessary here to make out the minutiæ of Artillery duties during a siege, which becomes a question of detail and of economical arrangements of stores, ammunition, and laboratory duties, and the judicious distribution and employment of the men, which fall exclusively on that department.

APPENDIX II.

PROPORTION OF OFFICERS OF ENGINEERS, SAPPERS AND MINERS, AND ENGINEER STORES, NECESSARY FOR A SIEGE.

In regulating this proportion, some data must be fixed suitable to all places and to all circumstances: classifying the fortresses under the following heads will be most applicable to our Service:

Maritime fortresses . . .	First class, or most considerable. Second „ or small places.
Fortresses in the interior, or on land frontiers . . .	First class, of 10 sides and upwards. Second „ of 6 to 10 sides. Third „ of 4 to 5 sides.

And the arrangement for calculating the number of officers and men must be separated from that for the requisite quantity of stores; the latter being regulated on the maximum quantity necessary.

The proportion of officers and men may be calculated upon the same rule as that

which provides for the Artillery and men of the Line in Appendix I. and IV., viz.: 1st, for the ordinary duties of a fortified place; and 2nd, in the event of a siege.

For the first it is proposed to assign

To the second class maritime, and third class land fortresses . .	3 Officers of Engineers, and 1 company of Sappers and Miners, including Officers.
To the first class maritime, and second class land fortresses . .	5 Officers ditto, and 2 companies ditto ditto.
To the first class land fortress . .	7 Officers ditto, and 3 companies ditto ditto.

And on the probability of a siege, that force to be doubled.

Under the latter circumstance it is usual to divide the whole into three reliefs, which will be found then generally inadequate; and a certain number of artificers, usually found in regiments of the Line, will be attached to the Engineers, which is alluded to in Appendix IV. in calculating the necessary strength of the garrison.

The proportion of stores, &c. requisite for a siege.

These essentials and indispensable resources to the Engineer department are threefold,—tools, stores, and materials; and the quantity necessary will be regulated by different rules; the first by the strength of the garrison, the second by the quantity of artillery, and the third by the nature of the fortress,—observing that the works are presumed to be in a proper state of repair.

TABLE A.—Appendix II.

List of Tools necessary to sustain a Siege, calculated upon half the maximum Garrison, although only one-third or one-fourth could be employed: this allows for waste and accidents. (See Appendix IV.)—Per 100 men.

Adzes	1	Jumpers, smallest	$\frac{1}{2}$
Assortment of Carpenters' tools	$\frac{1}{2}$	Levels, Masons'	$\frac{1}{2}$
„ Miners'	$\frac{1}{4}$	Miners' needles, of sorts	1
„ Masons'	$\frac{1}{8}$	Sap forks	1
„ Smiths'	$\frac{1}{10}$	Saws, hand	5
Axes, felling	5	„ cross-cut	2
„ pick	70	„ pit	1
„ broad	2	Shovels, long	5
Barrows, hand	5	„ common	60
„ wheel	10	Spades	10
Bill-hooks	30	Spare helves	50
„ hand	5	Scrapers, Miners'	1
Crow-bars	3	Sledge-hammers	5
Cart, hand	$\frac{1}{2}$	Tamping-bar	$\frac{1}{2}$
„ single horse	$\frac{1}{2}$	Screw or lifting jacks	$\frac{1}{2}$
„ timber (or devil)	$\frac{1}{2}$	Grindstones, large	1
„ forge	$\frac{1}{2}$	Scaling ladder, lengths of 10 feet	5
Jumpers, long	1		

TABLE B.—Appendix II.

List of Stores for the Defence of Fortresses, calculated upon the quantity of Artillery.
(See Appendix I.)

				No.
Chevaux-de-frize, of 10-ft. lengths, calculated for 15 pieces of ordnance				15
Fascines, revetting, 18-ft.	,,	,,	,,	200
,, chokers	,,	,,	,,	5
,, mallets	,,	,,	,,	5
Gabions	,,	,,	,,	100
Nails, spike, 5-inch	,,	,,	,,	100
,, ,, 7-inch	,,	,,	,,	50
,, ,, sorts	,,	,,	,,	500
Platforms, Madras	for ordnance in store for second period of attack			12
,, mortar	for ordnance in store for second period of attack			6
Sand-bags	,,	,,	,,	12,000
Rope, coils 3-inch	,,	,,	,,	½
Rope, coils 4½-inch	,,	,,	,,	½
Iron 2[e] blocks to suit ditto	,,	,,	,,	½
Ditto snatch ditto	,,	,,	,,	½
Timber for magazines			cubic feet	50

See 'Block.'

TABLE C.—Appendix II.

List of Materials for the Defence of Fortresses, according to their nature in the proportion of each Front of Attack.

	Wet ditches, and ample bomb-proofs.	Dry ditches, countermined, and ample bomb-proofs.	Dry ditches, not countermined, and ample bomb-proofs.	Without bomb-proof.	One-half bomb-proof.	One-third bomb-proof.
	per front	per front	per front	per front	per front	per front
Gunpowder, barrels	5	100	10	,,	,,	,,
Voltaic apparatus	1	4	2	,,	,,	,,
Iron, round, ℔s.	50	50	50	50	50	50
,, flat, ℔s.	100	100	100	100	100	100
Pontoons, Blanshard's, large	50	,,	,,	,,	,,	,,
,, ,, small	50	,,	,,	,,	,,	,,
Portfires	1	20	2	,,	,,	,,
Plank* 3″—ft. sup[l]., for repair of bridges	100	50	50	,,	,,	,,
blindages	200	200	200	200	200	200
with countermines	,,	150	,,	,,	,,	,,
without do.†	,,	,,	4500	,,	,,	,,
Timber—ft. cube, repair of bridges	100	50	50	50	50	50
,, blindages†	,,	,,	,,	5000	3000	2000
with countermines	,,	50	,,	,,	,,	,,
without do.†	,,	,,	450	450	450	450
repair of palisades,† stockades, barriers, and gates	250	250	250	250	250	250

* This 3″ (the most generally serviceable) stuff to be cut into 1½″ for mining purposes.

† These quantities can only be considered as approximate and probable. The whole character of these Tables is rather that of reminders and general assistances; attempts at precision would be vain. It must be remembered that the above quantities are for one front only; when multiplied by the number of fronts in the whole polygon, they will probably insure a sufficiency for those attacked.

The Engineer operations in the defence of places are usually—

First, previous to the investment, to provide a sufficient quantity of fascines, gabions, and timbers, in the proportion given in Tables B. and C.; and in respect to masonry bomb-proof cover, the complement should be supplied as follows:

Third class land fortresses, and second class maritime	Two-thirds of the garrison, and all the ammunition and stores, should be in the masonry or blindage bomb-proof cover.
Second class land fortresses, and first class maritime . .	One-half of the garrison, all the ammunition, and two-thirds of the stores.
First class land fortresses . .	One-third of the garrison, all the ammunition, and one-third of the stores.

This rule is based upon the principle, that the larger the fortress, the greater the difficulty to bombard it effectually; and upon the consideration likewise, that maritime places, when besieged, are liable to bombardment from gun-boats and vessels of war.

The second description of duties usually assigned to the Engineers lies in the requisitions of the Artillery, Commissariat, and Medical Departments, which are made on them when a siege is probable, consisting of side-arm-sheds, fitments for stores, expense magazines, and additional security to the powder magazines for the artillery. The Commissariat usually require ovens and stores to be secured and fitted; and the Medical Department, a proper provision and safety for the sick and wounded. These demands are in addition to those adverted to in the Instructions, for rendering the defences complete. Hence it is assumed that the fortress is in a perfect state of defence, and requiring only those works necessary after the investment.

When, then, this event has been consummated, and the front of attack understood, the Engineer operations should be confined (all the previous wants being supposed to be completed) to the construction of traverses and parados, cutting and revetting the embrasures, and laying platforms for the artillery which will now be brought into action: the artillery for immediate defence hitherto only having been used against the early period of attack, that necessary to sustain the brunt of the siege should be brought from store, and placed in battery on the fronts of attack and the collateral fronts. The execution of these works will fully occupy one-third of the Engineer department night and day to prepare the whole for the artillery by the time the first parallel is completed, and the emplacement of the enemy's batteries begun.

After these defence batteries are completed, and during the contest for superiority between the artillery of attack and defence, which may last, as it has been before suggested, from forty-eight hours to a week, the Engineers should prepare such resources as circumstances dictate in countermines executed at the moment, tracing such intrenchments as may be necessary to the covert-way, outworks, and front of attack.

The third important Engineer operation is (after the destruction of the parapets, palisades, guns, and carriages of the besieged,) when the débris has to be cleared, parapets to be repaired, new platforms laid, fresh embrasures cut, blindages and bomb-proofs to be re-covered and repaired, new traverses constructed: these will probably be executed under a heavy fire of guns, mortars, and small arms; advantage, however, must be taken of the dark, when the besiegers are equally well employed. During these operations the countermines and intrenchments should progress, so that one-half of the Engineer force will be in full employ.

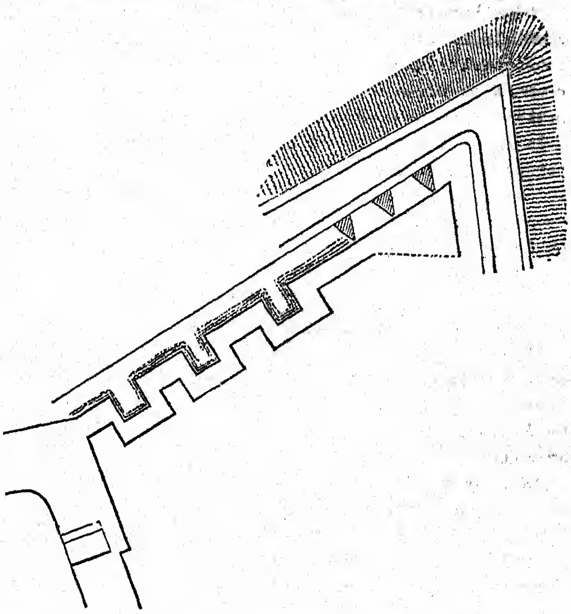
After this there will be another lull, except to those employed under-ground and in the intrenchments.

The next period, the most interesting to the Engineer, is when the defence wholly depends upon his exertions (the artillery for defence now being passive), and comprehended between the advance from the second parallel to where the breaches are

effected. It is during this time that well-directed sorties, conducted and executed by the men employed under the Officers of Engineers, can protract the advance, and thus turn the defensive into offensive operations: these sorties, frequent and in small numbers, should be accompanied by workmen with the means of setting fire to the gabions and fascines, sap forks for upsetting the sap, and each man with two or three nails to spike the ordnance, if the sortie should be sufficiently successful.

Want of skill in the Besieger, or other favourable circumstances to the defence, may render the counter-approach practicable, in the manner described in the figure below; and if a few fougasses (by placing boxes of powder or large shells) are employed, they will render a lodgement of the enemy difficult. The voltaic apparatus will now come into use.

Diagram of a Counter-approach—for a Collateral Front.



Among other resources, at this period of defence, is the application of mines prepared after the investment, the place not being countermined as explained in Appendix V. For the regular system of defence by countermines, see 'Military Mining.' The chicanery of water manœuvres when the ditches can be filled at pleasure, sorties, counter-approaches, and mines, must be guided by opportunity and local resources, rather than by any prescribed rules on paper: and if the attack is in force, all that can be expected is to protract the defence, and render the relief of the fortress possible; or, if the attack is weak, to oblige the enemy to raise the siege.

If none of the above are available, and the breaching batteries are established, the final question of defending the breach has to be considered. Without permanently intrenched bastions, the only effectual means are when the ground within the front attack is favourable, or when strong buildings immediately in rear of the breaches can be barricaded, and the enemy obliged to bring their artillery across the ditch: with these advantages, the breaches may be defended by means of fougasses, powder-

bags, grenades, live shells, and fire-barrels filled with pitch and fagots, rolled down. Large fires have been also successfully adopted in peculiar situations, to sustain an assault on the Body of the Place.

It has been observed that the Instructions drawn up by Carnot might have the effect of giving an undue value to fortified places, and yet they should not be deemed as mere time-pieces, destined to go so many days or weeks; for that author no doubt considered that sieges were frequently undertaken with insufficient means, tempted by the neglected state of the works, or weakness of the garrison, and that an efficient siege equipment was an affair of immense magnitude, difficult to transport. However, it is when a fortress is attacked with inadequate means, that an enterprising Governor, assisted by a skilful Engineer, can take advantage of it, and convert what was deemed weak into one far above its supposed strength, as occurred at Burgos when defended by the French, and at Tarifa when defended by an Anglo-Spanish force.

See 'Battery,' Pl. II. figs. 6, 7.

It has been omitted to provide for mantlets for the embrasures; for after the establishment of the third parallels, it will be difficult without them for the artillery-men to work the guns. Sand-bags should be piled on the crest of the parapets to cover the marksmen, who, even after the works are destroyed, can place themselves in the ruins, and, covered by a few sand-bags, keep up a heavy fire.

In the defence of the Castle of Scilla (Sicily) by the British troops the masonry parapets were levelled; yet a few good marksmen used to creep upon their bellies, and waiting the effect of an 8-inch iron mortar (which could not be silenced), they poured in their fire on the people as they ran out of the battery, who always dispersed on the appearance of the shell in the work.

APPENDIX III.

PROVISIONMENT OF FORTIFIED PLACES.

The quantity of provisions or commissariat stores necessary for a siege is one of the first essentials, and the supply for the inhabitants should be considered, as well as provision for the garrison; for notwithstanding every means are taken to induce the families to provide for themselves, their resources are found inadequate, and they are eventually supplied from the public stores.

Perhaps it would be better to take this into consideration at once, and provide a minimum ration, for each adult, of one pound of flour or meal.

In respect to the garrison, as it will probably be after the investment left wholly to the resources in the public stores, and as the duties will be very severe, it should be placed nearly upon the allowances given to Her Majesty's Navy when at sea.

Table of Provisions for Troops necessary for a Siege for 56 *days, for* 100 *Men.*

		Articles.		Bulk in cubic feet (allowing for barrels, &c. &c.)
		Flour or meal	2200 lbs.	76
		Biscuit	5600 „	358
	or	Beef, salted	5600 „	216
		Pork	5600 „	202
	or	Rice	2200 „	70
		Peas	1400 pints	54
		Cocoa	700 lbs.	41
		Sugar, soft	525 „	14
	or	Spirits	1400 pints	56
		Wine	5600 „	224
		Vinegar	200 „	8
Forage,		Hay for 20 horses for 56 days	7 tons	4000
	or	Barley	7200 lbs.	160
		Oats	7200 „	250
		Straw, ditto as hay	7 tons	4000

	ARTICLES.			Bulk in cubic feet.
Fuel for cooking only.	Wood	. . .		1280
	or Coals	. . .	7 tons	350
	or Turf.	.	(Kish of 20 cub. ft. = 100 lbs. coal)	3000
	Oil .	. . .	40 gallons	4
	Candles	. . .	40 lbs.	3

The bulk of these articles is given, in order that bomb or splinter-proof covers may be provided for the combustible, and adequate stores for the incombustible.

APPENDIX IV.

Strength of Garrison, Quantity of Ammunition, Arms, and Stores, necessary for a Siege, exclusive of Artillery, Engineers, and Commissariat, provided for in Appendixes I. II. and III.

The authorities given are so vague and unsatisfactory, that it is deemed preferable to form new data upon considerations framed from experience, in addition to the usual rules given upon these subjects.

In respect to the *strength of the garrison*, the principle proposed for the supply of artillery seems adapted also for the contingent circumstances to which a fortress is liable. The force required, therefore, will be regulated, first, for the immediate security of the place, and then the number to sustain a siege: this arrangement avoids the necessity of shutting up a considerable body of troops without an immediate object.

It is proposed to appropriate *per bastion*, or each front of the fortress, first, for the immediate security of each place, 350 infantry rank and file,*

10 cavalry „
60 artillery „
20 sappers „

440 per bastion,

and double that number to sustain a siege for the fronts susceptible of attack; for in maritime places the former proportions will be probably adequate for the enceinte generally.

The latter additional force to be thrown into the place by the General commanding the army when there is any probable risk of its having to sustain a regular attack.

Of the two evils, of either having garrisons not fully adequate for his fortresses, or having a large body of troops unnecessarily pent up within them, the General commanding will find the latter very likely the greatest.†

The quantity of ammunition, arms, and Quarter-Master-General's stores, are proposed for the maximum forces in the following proportions:

Surplus arms, 1 for every four men.
Wall-pieces, 10 for every front of fortification.
Ammunition for ditto, 500 rounds each wall-piece.
Musket-ball ammunition made up, 500 per man.
Lead, 10 lbs. per man.
Cartridge paper, 1½ quire.
Hand-grenades, 10 per man.
Gunpowder in barrels, 2½ lbs. per man, (exclusive of wants of Artillery and Engineer Services.)
Barrack bedding, 1 set per man.

* This provides for the probable requisitions from the Artillery and Engineer Services.
† For defence of polygonal fronts 800 of all arms are considered necessary.

Shoes or boots, 3 pairs per man	These are in addition to those in possession of the troops.
Spare haversacks, ½ per man	
„ great coats, „	
„ canteens, „	
„ blankets, „	
„ camp kettles, 1 for every 20 men	
Tools, felling axes, 1 for every 16 men	Exclusive of Engineer stores.
„ bill-hooks, „	
„ pickaxes „	
„ shovels, „	
„ hand-saws, „	

APPENDIX V.*

MINING OPERATIONS WHICH MAY BE UNDERTAKEN IN THE DEFENCE OF FORTRESSES WITHOUT COUNTERMINES.

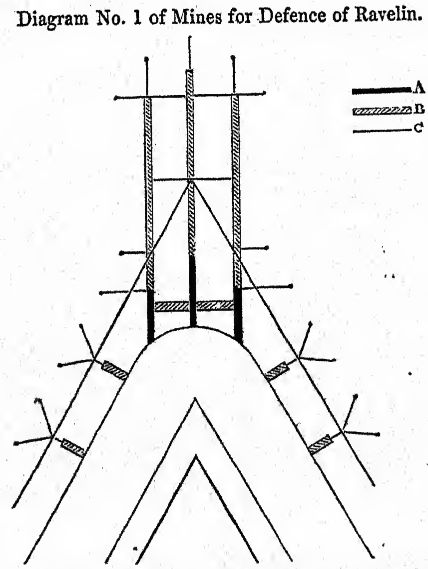
Supposing a decagon entirely without countermines, it will now be explained what mining operations may be executed to strengthen the place and protract the defence.

1. For this description of fortress there should be, at least, 72 good miners, who, being subdivided into brigades of two each, so as to afford the necessary reliefs, will be reinforced by four men of the line to each brigade.

2. In commencing work, the fronts most likely to be attacked should be chosen; but if all fronts are equally liable to be attacked, (which case will be supposed by way of example,) all must be provided with this means of defence.

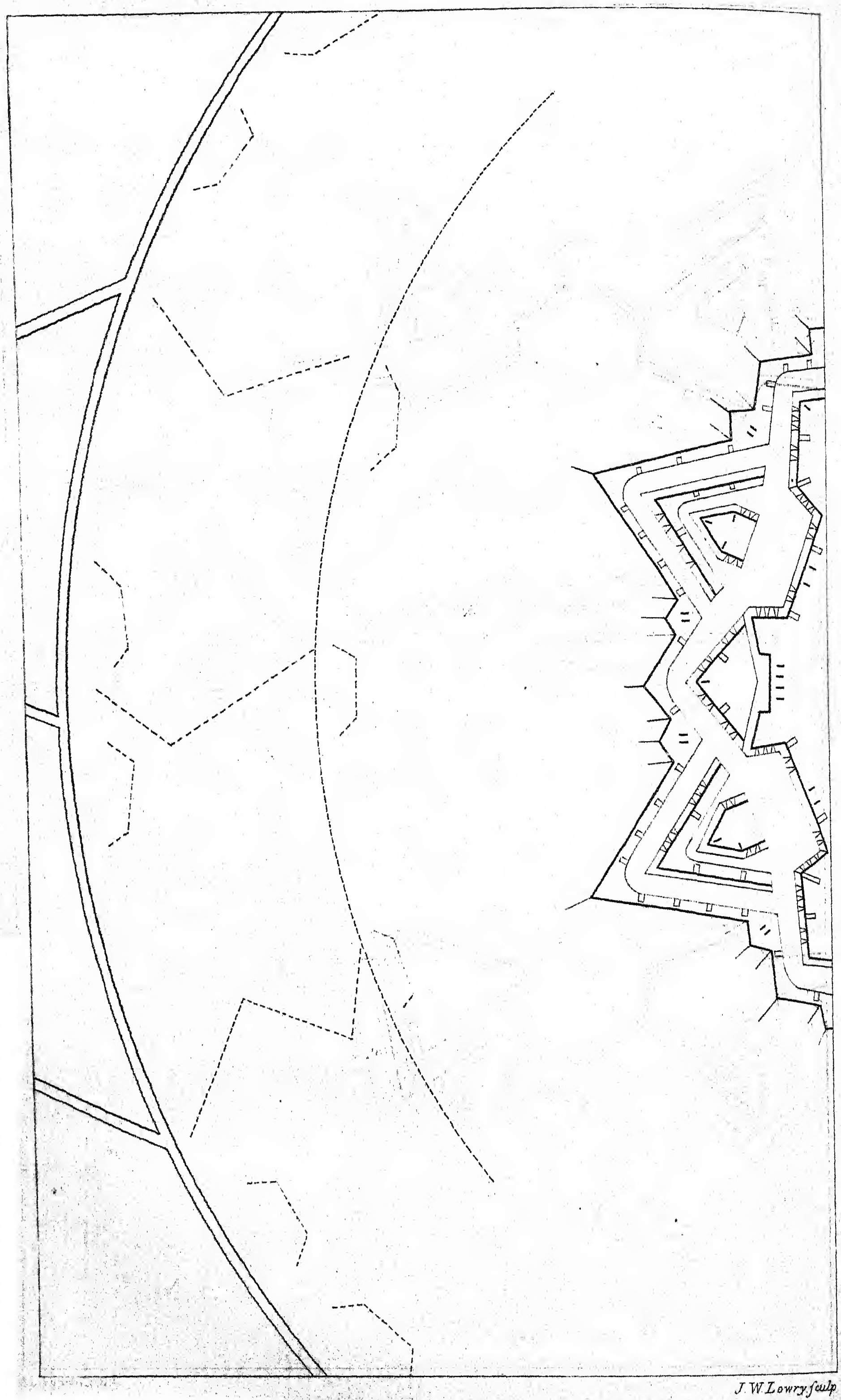
3. This question being decided upon, and presuming that the investment will last 10 days, a brigade of miners should be placed on the capital of each ravelin, and three principal galleries executed, as described in the diagram No. 1, and extended as demi-galleries to about 60 yards from the counterscarp, which will bring them to where the listeners' or branch galleries should commence, at least 20 yards from the salient angle of the covert-way.

Diagram No. 1 of Mines for Defence of Ravelin.



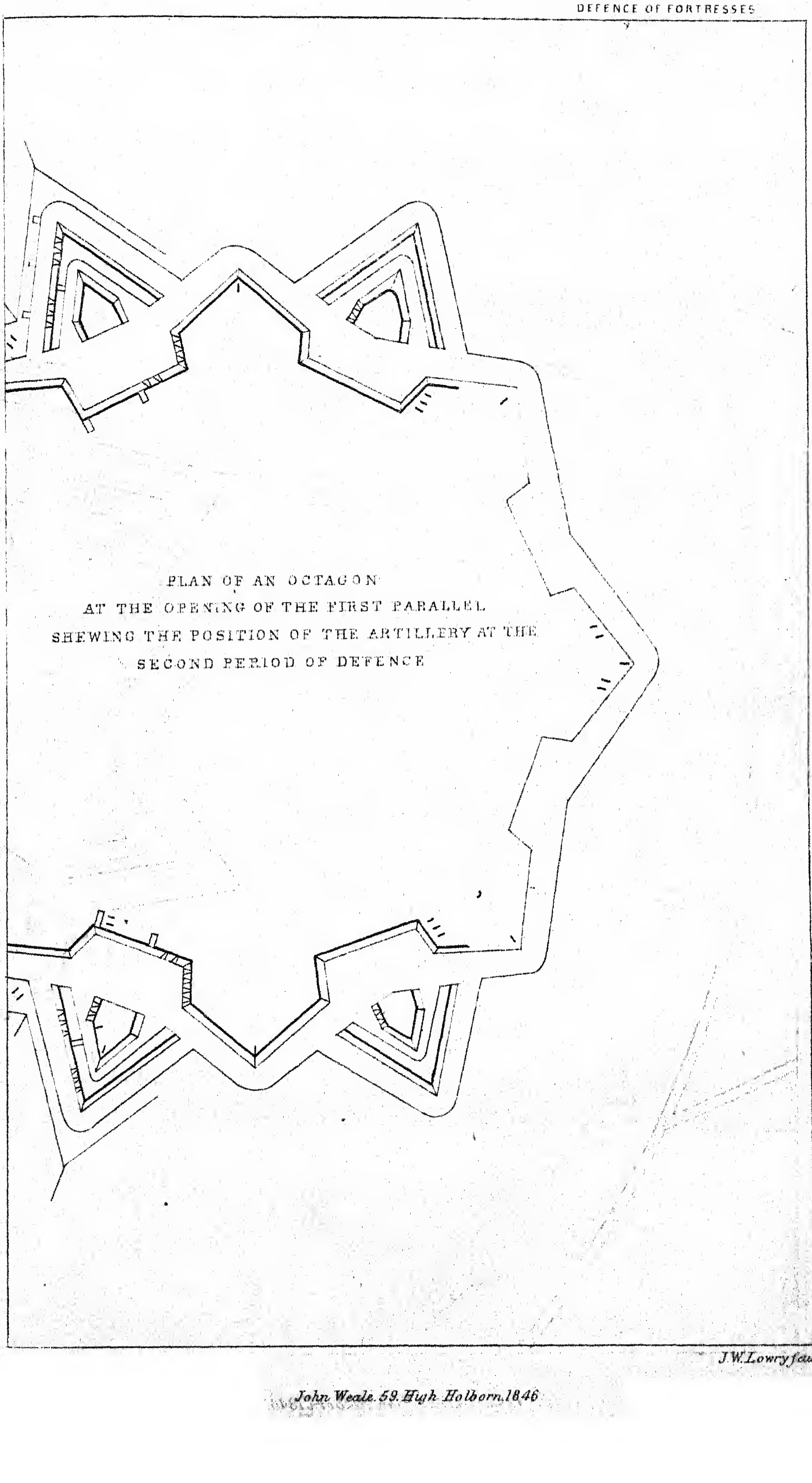
A. Principal gallery. B. Demi-gallery. C. Branch.

* Taken from 'Manuel pratique du Mineur,' by Villeneuve.



J. W. Lowry, sculp.

John Weale, 59, High Holborn, 1846.



J.W. Lowry sculp

John Weale. 59. High Holborn. 1846

4. As soon as the trenches are opened and the fronts of attack known, the brigades of miners will unite from this period until the cavaliers of trenches are established on the glacis, which may be conceived to extend to 12 days more, and complete the galleries and branches as follows:

5. For the ravelins, the galleries may be prolonged as branches or listeners 30 yards, and externally 10 yards right and left; these, when completed, will afford for each of the collateral ravelins of the bastion attacked—

Principal gallery,	26	yards,
Demi „	178	„
Branches „	255	„

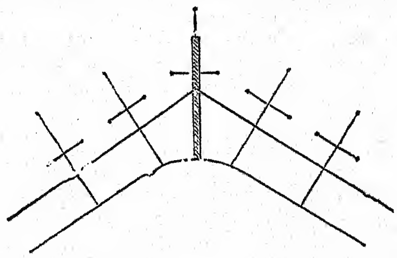
which may be easily excavated in 12 days.

6. For the bastion, there will be sufficient miners left to work at the mines to be placed under the site necessary for the breaching batteries of the enemy, the branches of which will amount to about 220 yards—one portion being placed on the capital, and two on each side, so as to include the counter as well as the breaching battery; and it will require 14 days to execute these works. See Diagram 2.

7. It may be observed, that if the bastion attacked is very retired, or rather, if well covered by the collateral ravelins, the mining operations may be confined to the salients of those ravelins; but if the contrary is the case, then the glacis of the bastion must be principally provided with this species of defence.

The probable expenditure of gunpowder will be about 7 barrels of 90 lbs. for each mine or explosion.

Diagram No. 2 of Mines to be placed in the Glacis of the Bastion.



G. G. L.

DEFENSIVE PRECAUTIONS.*

When a fortress is on the point of being invested by an enemy's army, the Governor, in order to anticipate the military reconnoissances of the hostile General, and obstruct the Engineers taking measures for opening the trenches, may draw from his own military stores, or by requisition from the merchants and shopkeepers in the town, a sufficient number of pieces of linen, calico, flannel, red baize, &c., to mask the capitals of bastions and the points which would be taken for opening the first parallel, causing these, under the direction of his Engineers, to be stretched along ropes, held up by means of poles along the glacis; where those long unexpected lines of white, green, or red, set so as *not* to correspond with the angles of the fortifications, will tend greatly to throw the opponent into error, and probably

Masking Works.

* Fragments by Colonel C. Hamilton Smith, K.H.

retard the trenches being opened for several days. These stripes of cloth should be altered more or less every night; in some places a second line of them may be raised from the points of the bastions, and carried obliquely to the curtains; and all the light troops acting as skirmishers should lie out on the glacis, as far in advance as possible, to prevent all nearer access by the enemy's scientific department and Staff Officers. Hostile shot will not very readily cut the ropes, and striking the cloth will not unmask the objects behind; but in order to leave less chance of the cloth being thrown down, each pair of poles fixed in a X shape should have the rope securely knotted, and they should not be more than 15 yards asunder.

Chains of Advanced sentries.

When a General invests a fortress, the commanding Engineer, though he may be materially impeded by the foregoing precautions, must not, however, suffer the Besieged to send out intelligent non-commissioned officers to creep in the night to the marks laid down by his Officers for the direction of the trenches, and change or withdraw them. He must not suffer patrols to come out, and endeavour to intercept all communication from within and without the place passing through the investing posts. Small but vigilant guards should for this purpose keep the most strict watch in the rear of the army, particularly at all bridges, fords, and narrows; the sentries keeping perfect silence, unless when challenging, and then it should be done with no more voice than is necessary for the purpose.

As the Engineers within a besieged place are fully aware of the weakest points in their defensive system, so they must be expected to be most jealous about them, and watch them with the utmost anxiety. In forming therefore the investment, it may be as well to give them uneasiness or even expectation that the Besieger has mistaken the weakest part, by affecting to push cautiously forward such light troops as are destined to approach nearest to the glacis on those points which are only of secondary consideration: but the true front to be attacked should be covered by riflemen, who, formed in chain by fours at the distance of twelve or fifteen yards from each other, advance as soon as it is sufficiently dark to prevent being distinguished by the enemy; officers and serjeants keeping even with the line, and the connection of the links being maintained by the slowness of the movement and the occasional sound of a light *tap* upon the pouch of the right-hand man of each link passing from right to left, and then back again. On coming within the range of grape, or when the commanding Officer judges it to be time, they will receive a similar low preconcerted signal to drop on their hands and knees, crawling forward to within two hundred yards of the glacis, when *three taps* to halt will be given by the commanding Officer, and all are to remain (in their great coats) as near the ground as possible, excepting one in each link, who sits upright, or stands if there is cover, until relieved by his companions. The officers and non-commissioned officers watch on the flanks, or crawl from link to link. None are permitted to smoke, or speak louder than a whisper; none to quit the links on any account towards the front; the Officer visiting the line not to be challenged, nor to respond but by preconcerted taps on the pouch, the powder-horn, or other token: none to challenge persons coming from the town until they have passed through the line of chain, and then they must be followed by a serjeant with two or more men taken from the nearest links, who in a low voice will desire them to surrender without making a noise, on pain of instant death. The person, deserter, spy, or messenger, must then be carefully watched, lest he should drop letters, &c., led directly to the rear, and given in charge at the first post, and there searched, to be dealt with as may be ordered by the Officer in command of the trenches. But persons coming from the rear towards the town

must be stopped, if possible, before they reach the chain, and, if strangers, treated like the first mentioned.

Should a patrol of some strength come on and pass through the chain, a sufficient number of links, making eight, ten, or twelve men, will collect, follow it, and cut off its retreat, if possible, without noise, and in no case shew more of the chain than is necessary. Should light-balls be thrown out, all must lie down, immoveable, till their fire is spent. Just before dawn, the chain will draw further back, but not retire, because sorties are likely to be then made. Therefore several non-commissioned officers should remain behind, lay an ear to the ground, listen attentively, or even crawl up to the palisades before they fall back. Of course the troops in the trenches are then under arms. In this manner the front of attack will be thoroughly watched, and, with sufficient light troops similarly instructed, not a single hostile individual can enter or quit the place.

Defensively.

When the case is reversed, and the fortress is to be defended, it follows that all the instructions must be taken in a contrary manner; and the rifles in a place besieged, if trustworthy, should be kept as long as possible beyond the glacis with similar precautions.

These remarks are intended for the Engineers, who may often find the troops employed on the occasion of expeditions and distant sieges unprepared by any previous instruction on this head, and therefore will then be obliged to cause some preparatory drill to be given to the troops at hand, so that they may effect the purpose intended with order and punctuality. Commanding Officers of battalions will be able to tell whether their light companies are taught the above method of enclosing enemies' fortresses, or of watching posts of importance in this manner.

At Gertruydenberg, during the late war, where the escarps were of earth, and unprotected by fraises, the writer of the above rendered them inaccessible during the winter by throwing water over them, so as to encrust the whole exterior slope with a sheet of ice.

At the siege of Dantzig, in 1813–14, on the other hand, the ditches were prevented from being frozen by row-boats being kept constantly moving up and down.

DEFENCE OF COASTS.*

In offering suggestions for the defence of open shores, harbours, and rivers, it is necessary to advert to the several securities required for these situations, whether from predatory attacks, or from those of a more serious character, directed against an asylum for commerce, a dockyard, &c.

For the first, extensive works are seldom required; but for the latter, it may be proper to afford protection for single vessels or fleets according to circumstances, in addition to the security given by the roadstead, river, or harbour.

GENERAL CONSIDERATIONS

are,—those of localities, whether the point to be fortified is near or distant from the principal towns or naval ports; if the access to those places from the landing is good; if through defiles easily defended, or an open country. If the point to be defended is remote, the question may be confined to the local damage probable, or whether it may serve as a harbour of safety to trading vessels, particu-

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* By Major-General Lewis, C.B., R.E., with notes from Major-General Harding, R.E.

larly to the coasting trade; or the site may be so remote and the approaches from it so difficult as to render any expensive works superfluous: or the consideration may be that the point is favourable for a debarkation to assist a population hostile to the existing government, and serve to secure ulterior proceedings to an enemy.

If the object should be to secure the possession of a harbour or river, the question will be, can it be forced? by this means the town or shipping destroyed? and whether the hostile vessel or vessels, having forced the harbour or river, can return by the way they came, or by another outlet; or, having effected an entrance, may land, reduce the defences, and accomplish the object of attack, without further risk from the batteries?

In selecting sites for coast defences, the means of supporting the works by a moveable force is of importance, either by armed steamers and gun-boats, or by columns of troops whose position is fixed at some central point in the interior. Railroads forming an auxiliary in the conveyance of troops, with this assistance, a central point at 60 miles radius would form a good support; (without railroads it should not exceed 15 miles from the central position;) so that intelligence may be conveyed on railroads by the electric telegraph, and the support afforded in a few hours.

The composition of moveable columns of support to the coast batteries may be from 500 to 5000 of all arms, in proportion of seven-tenths infantry, one-tenth cavalry, and two-tenths artillery, the latter being an essential arm to oppose the debarkation of troops; the strength of the force depending upon the probable object of an enemy, as well as on what power may hold the maritime supremacy of the adjoining sea, and the proximity to an hostile armament.

Possible causes and objects of attack may be—conquest or the destruction of commercial ports of more or less value, the naval arsenal, or considerable manufacturing towns,—the possession of the principal dépôt, or capital of the State or Dependency; or taking advantage of the weakness or absence of troops. These possible contingencies should be carefully considered in distant stations and colonies, as well as the various questions alluded to above, in order to economize the resources of a country, and prevent an unnecessary dislocation of the forces.

THE NATURE OF WORKS MOST SUITABLE FOR COAST DEFENCES.

The instructions of Napoleon upon this subject are applicable to this point, as there is no fixed principle for the construction of works for the armament of coasts, and the question gives rise to perpetual discussions on which he has decided.

"1. That works of the first class should be assigned for the security of the entrance of a principal harbour for ships of war, be well armed, their gorges protected by a masonry barrack as a keep, capable of bearing upon the summit four pieces of ordnance and accommodation* for 60 men, with their provisions and stores and powder magazine, so as to be secured from a coup-de-main."

The battery should have a reverberatory furnace for heating shot.

"2. Batteries required for the security of harbours and roads used for commercial purposes should be of the second class, and also have at the gorge a keep in masonry, and sufficiently strong to bear two pieces of artillery, having accommodation for 30 men, with the necessary magazines."

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* In the formation of batteries regard should also be had to the probable number of men that may be obtained to serve them. Five men are usually allowed to each gun, but as assistance can generally be obtained from the Line or the local population, the calculation may be grounded on two artillerymen for each gun likely to be in action at the same time. As sea batteries are kept in a state of readiness for immediate action for years, attention should be paid to secure dry cover for the ammunition, stores, and side-arms; and the guard-room and barrack secured from surprise.—G. J. H.

"3. Finally, for batteries required at isolated points, they should be of the third class, and have a masonry work at the gorge capable of carrying a carronade, having accommodation for the men and magazines, but without counterscarp or covert-way."

In the selection* of the site of coast defences the following points are to be considered.

1. The form of the work.
2. The height above high-water mark.
3. The distance within which shipping can approach the shore.
4. The quantity of ordnance necessary, and their nature.

1. The form or shape of coast defences, if not decided by the locality, should be regulated by the object of defence: if to dispute the passage† into the river or harbour, or roadstead or bay, or anchorage, the face of the work will be necessarily perpendicular to the approach, so as to rake the vessel as she advances and recedes, taking care, as she shews her broadsides, to cover the battery as much as possible: if the vessel should remain under fire about 20 minutes, a shot furnace should be in the battery: if she can anchor within range, two or three mortars should form part of the armament, and the entrance or gorge of the battery should be secured by an interior work capable of containing the necessary number of men and stores.

If under 45 or 50 feet above high water, the artillery should be placed upon traversing platforms. This last arrangement requires a larger interior space, each gun or howitzer so mounted requiring, at least, 30 feet from centre to centre.

The parapets of all coast and harbour defences should be constructed of earth or some composition that will not break into dangerous splinters, except those of towers and casemates, and the circular shape of the former renders them difficult for the guns of ships to strike effectively.‡

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* In the position of coast batteries regard must be had to the anchorage, channels, banks, rocks or shoals, set of tides and currents, prevailing winds, &c., and the emplacement made to take advantage of these difficulties. These batteries should be as near the shore as possible, in order by their front, flank, and reverse fire to obstruct a landing; and by a judicious selection of sites, an enemy would not attempt it but with a superior force. If the position should be on one of the flanks of the landing place, and the work of such strength that it could be maintained after a debarkation was effected, a coast battery of this nature would have considerable influence upon the movements of the hostile force. When a coast consists of high cliffs, broken by practicable ravines, it is seldom advisable to place the batteries on the advanced points: the guns are too high to have much effect, and they are exposed to be cut off; the defence should rather be on the beach in the first instance, and at the top of the ravines in the second.—G. J. H.

† The landing of troops is generally attempted on a beach off which the ships of war may anchor to cover the debarkation: most beaches have headlands or projecting points, from which, if not too distant, a flanking fire on them may be obtained.

These points, with this provision, should be taken up, to oblige the enemy's ships to anchor at a distance; and from these points to enfilade the lines of boats approaching the shore: as they may require a certain permanency of occupation, the works on them should be secured against surprise or assault, and armed with heavy guns, and provided to contain the necessary accommodation for men and stores, and be enclosed in the rear.

The magnitude of the work will of course depend on the importance of the point and nature of the ground.

The projecting points frequently serve to protect vessels anchoring in the bay, and, if fortified, will prevent small landings on predatory purposes, and also impede any serious attempt, and by a flanking fire support the force brought to oppose the landing. Beaches are frequently backed by sand-hills, which should be formed into parapets for infantry and field artillery, and by their rapid fire would render a debarkation difficult.—G. J. H.

‡ The parapet of a battery is so much weakened by embrasures, which also are so liable to injury, that they should not be used in coast and harbour defences except in particular cases. Traversing platforms are preferable on any height, and the difference between a gun mounted on a ground platform and the former is too inconsiderable to render the latter preferable as regards height;

2. In deciding upon what height the emplacement of a battery should be above high-water mark, 30 feet should be considered the minimum, if not casemated, and 60 feet the maximum height. But in selecting the best heights, reference must be made to the distance within which a ship of war can approach a battery: the crest of the parapet, where there is any choice, may be regulated by the effect of the ricochet fire on the vessel, if not within 2000 yards.*

See Table II.
See Appendix II.
See Table II.
See Appendix II.

In the event of vessels of war being able to approach within 800 yards, the cover to the interior of the battery must be regulated by the following depths of water.

First rates will require		36 feet water.	
Second	„	30	„
Third	„	24	„
Fourth	„	18	„

Steamers from 15 to 21 feet.

3. The distance within which shipping can approach a battery is of importance, as the level of the quarter-deck of 3-deckers is 26 feet above the line of flotation.

See Table II.

2	„	19	„
Frigates		13	„
Steamers		11	„

It rarely occurs that vessels of a small class contend with batteries, however feebly armed.

If ships of war can approach very near on an equal level and above the batteries, the latter are seldom tenable unless they are casemated; and if they can anchor, the destruction of the work is inevitable: this can only bė avoided by a counterguard or work in front; but the battery will probably be silenced.

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the traversing platforms also give a facility of traversing when directing a shot against a moveable object, such as a boat or ship.—(See Appendix I. on the mode of working these platforms.)

If the batteries be well constructed, the direct fire of ships has little effect, but the greatest care is requisite that the faces be not enfiladed, especially in rivers.

A battery should expose as little escarp as possible; if on a cliff, it may be scarped, and the superior slope of the parapet formed to meet it.

Coast batteries should be so constructed as to oppose a face to every point from which they may be attacked.

When the ground round the beach rises high in rocky points or slopes, consideration must be given to the height of the batteries: too great a height renders the fire of little effect, without gaining any advantages; but batteries just placed so that the guns of the ships can with difficulty be elevated to them fire with great effect, and in security.

It is a great object to direct a heavy fire on ships before anchoring, especially at the rigging, as the loss of a spar and few ropes may oblige them to anchor when not intended, and thus derange at the same time the position of all the following ships.—G. J. H.

* Batteries on the level of the sea are much used for the defence of the entrance of harbours and bays, and may be effective against small vessels or boats; but if large ships can carry deep water close in-shore, which is frequently the case in the entrance of harbours, the guns must be casemated, to cover them from the fire of the upper decks and musketry, or the embrasures arched over, so that the guns fire through portholes.

In the defence of entrances or channels, it should be an object to obtain a position so that the battery should have a cross fire, and be able to continue its fire after ships have passed; and under these favourable circumstances they should be armed with heavy calibre.

It appears advisable, when *practicable*, that sea batteries should occupy the crest of rising ground, and that the platforms should be placed on the natural soil, on the reverse of the hill, without embrasures, so that nothing but the gun itself is exposed. If such a position cannot be obtained, or the battery cannot be raised sufficiently to secure the merlons from the guns of large ships of war, the escarp should be covered by a glacis. But batteries cut out of steep banks, or ledges of precipices, or so that their elevation is considerably above that which can be given to artillery on the decks of vessels, render the interior of the battery dangerous from the splinters and débris from above, unless casemates or blindages are constructed to prevent these accidents.—G. J. H.

It is also an axiom, that vessels of war which can come within moderate range can drive the men from the battery; that between that and 500 yards they may destroy it; and within 800 yards they may silence it, when it is built à fleur d'eau, or when the upper deck guns are on the same level with the crest of the parapet.

See Table II.

If depth of water permits this approach, the battery must be casemated to prevent the first; in the second and third difficulties the battery must be 20 feet above the level of the main deck of the ship of war, and covered with an epaulement, counterguard, or glacis. If no vessel can approach within 1200 yards, the height of the battery may be left entirely to localities, having the parapet 7 feet 6 inches above the terreplein, and the guns mounted on traversing platforms.

See article 'Artillery.'

4. The number of ordnance necessary, and their nature, for the armament of a battery.

The first is influenced by localities, yet the purpose or object which the battery is to attain is the rule by which we are to be guided. In isolated spots, one, two, or three pieces may be placed on towers when the coast is low,* which have the advantage of combining barrack and magazines and stores for ammunition, and are not open to a coup-de-main.

If the ground is as high as 50 feet and more, above the level of the sea, that description of work should be avoided, as the summit of the tower is too high, even if sunk 12 feet with a ditch and counterscarp; but a small work for two or three guns enclosed by a ditch will be preferable.

When there is a large or considerable open coast to defend, several batteries will be required to produce a cross fire, not exceeding 4000 yards from each other, each battery containing five, seven, or nine guns, according to the nature and importance of the coast to be defended.

The nature of the ordnance should consist, when there is a choice, of one or two 68-pounders, as local circumstances dictate, and the 8-inch gun of 50 cwt. and 32-pounder long gun, with a howitzer on the keep or interior work, but this last corresponding in calibre with the guns. The supply of ammunition and stores to coast batteries is usually in the proportion of 50 rounds per piece for works of least importance, and 100 rounds for the principal batteries.†

See Table I.

The next point which should be considered is, that booms are necessary for the protection of harbours and rivers.—See 'Boom,' and 'Demolition' of Boom.

No battery or batteries, however strong, can stop or prevent any ship of war or steamer entering a harbour when the navigation is free and the course is nearly direct, *if she chooses her own time.* As examples—the conquest of Curaçoa is one upon a small scale, and the passage of the Dardanelles another upon the largest.‡

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* Large towers are expensive in proportion to their means of offence, but necessary in particular situations, as when the space is very small, or the position entirely isolated.

In regard to towers, it will be found that a battery, with the faces directed on the point required, and closed at the rear by a loopholed barrack, the whole surrounded as much as possible by a ditch and glacis, will contain more guns and men than a large tower, and at less cost.

Towers may, however, be used to great advantage in some situations, as on narrow points of shingle, or sand, or rocks, &c., or in commanding an entrance or strait when they are left to their own defence.—G. J. H.

† In the disposition of batteries, it may be well, for the convenience of the service in the necessary supplies, to place them in masses.

Guns have been sometimes placed in every situation where a gun could be useful, without sufficient regard to the service of them, or the communications with them.—G. J. H.

‡ See Table I. and article 'Ordnance;' also Appendix III.

APPENDIX I.

PLATFORMS.—TRAVERSING, IRON.

The positions of these on works have been regulated by the Master-General and Board's order, 9th March, 1810, with regard to iron gun-carriages,—"to be placed in such parts of fortifications as are least exposed to the enemy's fire; and in sea batteries to which heavy ships cannot approach nearer than 1000 yards." The splinters of even a wrought-iron carriage, at the usual distance from each other on board ship, will destroy at least the two next beyond it. Wooden platforms, as well as carriages, should always be in store to replace those of iron in case of attack; the chief merit of these last lying in economy and durability.

Figures 1, 2, 3, 4, Plates II. III., give the details of the regulation iron traversing platforms from 18-pounders to 32-pounders inclusive; the width between the trucks of all these carriages being the same, to suit the platforms: these last "may be adapted for front, centre, and rear pivot; and are so constructed, that by moving or reversing the bar that extends from the front pivot point to the half distance between it and the rear one, and by the alteration of the legs above the trucks, they may be made to traverse in any direction; and any alteration may be made that is required in the position of a traversing point between the front and rear."—"This must be done when the carriages are put together in the Royal carriage department at Woolwich," and this point must be stated in the demands.

There are yet old gun-carriages in the Service, with the trucks closer in the front than rear; and this must be seen to in receiving reports, especially from detached posts, when these platforms are required.

In addition to the above three modes of traversing, there is traversing on the *middle of the length* (not centre between trucks) of the carriage, which requires two curbs; this seems not to have been at first contemplated for iron platforms, but has been since carried into execution. This pattern must be specially applied for.

When the thickness of the parapet admits of it, these platforms are fixed with the fore end (G G, Plates II. III.) flush with the interior face of the parapet, and having a circular indent one foot deep in front: the true radius of this arc will be the distance from G to the pivot + 1 foot.

See Plate III.

	Pivot at front.	Centre.	Mid-length.	Rear.
The several radii of the indent will be	3′ 7½″	7′ 6″	9′ 0″	12′ 0″

It must be remembered that the gun, when much depressed, runs a great risk of being dismounted, on recoiling, by the lower part of the muzzle catching on the interior crest of the parapet, if not raised sufficiently above it. This may be avoided when any depression is necessary, by taking care that the crest of the parapet shall be one foot below the trunnion.

"Iron gun-carriages and platforms are to be coated with anti-corrosion every two years, and not painted."—See 'Anti-Corrosion.'

The dwarf or Emmett's traversing platform is now generally used, and supplied by Carriage Department, and even adapted to fire over a 6-feet parapet. See Plate I.

No regulation exists as to the proportion of wooden carriages or wooden traversing platforms that are to be kept in store in case of attack: it must depend not only on the greater or less liability to heavy direct, and enfilade fire, but on the durability of the timber, which varies greatly with the climate and with the power of the material to resist weather, both as to natural capability and proper protection by seasoning and painting, as well as to the extent of exposure.

Further, in the selection of either wood or iron traversing platforms, not only such

considerations as the above (which are of especial weight in tropical climates) should be taken into account, but likewise the immediate circumstances of the times, and place, which influence the likelihood of war or peace generally, particularly if under any circumstances the point may be expected to be suddenly attacked: in such instances the wooden platform is preferable, as more generally manageable, and incomparably less liable to accident: the mere fall of the heavier pieces of the iron platform is enough to ruin them irretrievably: not so the wooden platform, the repairs of which generally lie within the compass of colonial resources, and which may be made on the spot in most cases; but those of iron can only be obtained from England on demand.

Memoranda by an old Artillery Officer.—The blocks and tackles formerly used in working traversing platforms have been done away with, and thereby much of the efficiency of the platform itself, as to accurate and rapid firing *at a ship in motion*, has been lost. In reference to open batteries, these tackles were infinitely better, in this respect, than the handspike, and should always be in the hands of the artilleryman as part of the battery equipment, proper ring-bolts* being fitted for this purpose. In small towers, where the space is confined, the handspike may be preferable to the block and tackle. The gunners should be invariably drilled to load *overhand*, and thus avoid unnecessary exposure; a lock and laniard fitted, and the gun fired at the right moment in a way that never can be done when the movement is the irregular jerking one given by handspikes.

APPENDIX II.†

SERVICE SUR LES CÔTES.

La flotte et l'armée de terre sont chargées de la défense mobile.

Les bâtiments à vapeur et les flotilles armés d'obusiers sont particulièrement propres à la défense des côtes.

Des corps de troupes réunis dans des centres d'action se tiennent prêts à se porter sur les points menacés, des batteries mobiles d'obusiers de 16^{c} et 12^{c}, suivant les localités, prêtent leur appui à ces corps.

Un service rapide de signaux est établi, avec les ressources locales, entre les bâtiments, les vigies, les troupes mobiles et les batteries permanentes.

L'ordonnance du 3 Janvier, 1843, détermine: que dans les ports militaires, l'armée de mer sera chargée spécialement, sous les ordres du commandant des forces de terre, de l'armement, du service et de la garde de batteries qui ont une vue directe sur les ports, sur les rades intérieures adjacentes à ces ports, sur les passes et goulets conduisant aux rades intérieures, toutes les fois que les ouvrages auxquels appartiendront ces batteries, n'intéresseront pas principalement le système de la défense, du côté de terre, de la place et de ses dépendances.

Le personnel des batteries permanentes confiées au service de terre est fourni par l'artillerie, les autres troupes, les canonniers vétérans, la garde nationale, les brigades de douane, ou d'anciens canonniers pris dans la population des côtes, à raison de 5 hommes par pièce, dont un pointeur exercé.

Les ouvrages de la défense permanente sont divisés en 3 classes, suivant leur importance.

1re *Classe.*—Ouvrages destinés à la défense des ports militaires, des grands ports marchands et des points principaux des îles.

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* See Plates V. VI., where ring-bolts to correspond are shewn also on the ends of the platform as originally constructed.

† Extracts from 'Aide-Mémoire à l'usage des Officiers d'Artillerie,' 2nd ed. p. 402.

Cette fortification se compose de forts extérieurs capables de résister à des attaques régulières ou d'empêcher un bombardement, et d'une enceinte continue, suffisante contre une attaque de vive force.

2^{e} *Classe.*—Ouvrages qui protégent les mouillages et les passes propres aux escadres de guerre. Ils consistent dans un système de forts ou de batteries se rattachant aux places.

3^{e} *Classe.*—Ouvrages qui défendent les petits ports du commerce, les mouillages propres aux bâtiments marchands, les refuges de la navigation côtière. Ils se bornent à des batteries avec réduits.

Cette classification règle les approvisionnements des batteries; elle ne détermine pas d'une manière absolue leur armement, qui est subordonné à des circonstances diverses, non plus que la force de leurs réduits, également variable.

L'armement des batteries est réglé d'après la force des bâtiments qu'elles peuvent avoir à combattre, laquelle dépend de la nature de la côte, et principalement de la profondeur de l'eau.—Le tirant d'eau des bâtiments de guerre est à peu près, savoir:

Vaisseaux de	74 à 120 canons,	7^{m} 5 à 9^{m}	
Frégates de	44 à 60 „	6	à 7
Bâtiments de	24	5	
„	16	4	
„	10	3	

Les canons de 30* et obusiers de 22^{c}† de la marine sont employés à combattre les bâtiments en marche, jusqu'à la distance efficace de 2400 mètres. Les canons commencent le feu à boulet plein; on continue à tirer les projectiles creux. Les mortiers de 32^{c} ‡ de la marine, dont la portée s'étend à 4000 mètres, sont réservés contre les mouillages. Il résulte de l'expérience, qu'une batterie de 4 pièces de gros calibres a l'avantage sur un vaisseau de 120 canons.

Les projectiles ricochent mieux sur l'eau que sur la terre et perdent peu de leur force; ils peuvent, après avoir ricoché, traverser à 1200 mètres le flanc d'un vaisseau de haut bord. Les projectiles creux qui pénètrent dans les bordages au-dessous de la ligne de flottaison causent de larges voies d'eau par leur explosion. ('Epreuves de Brest, 1824.)

La hauteur à donner à la batterie au-dessus du niveau de la mer, est de 10 à 15 mètres. On doit se rapprocher autant que possible de ces limites, la 1re étant nécessaire pour mettre la batterie à l'abri des inondations dans les gros temps; la 2^{e} permettant le ricochet jusqu'à 200 mètres et suffisant pour éviter celui des vaisseaux, qui part de 5 à 6 mètres au plus au-dessus de l'eau.

La hauteur de la batterie se prend de la crête intérieure de son parapet. Elle se compose de son élévation au-dessus des plus hautes marées et de la quantité variable dont la mer se trouve au-dessous de ce niveau au moment du tir. Ces variations, qui sont inégales pour les différents points d'une même côte, et qui changent d'un jour à l'autre pour le même point, peuvent s'élever jusqu'à 12 mètres. Il importe de les bien connaître pour fixer la position de la batterie.

Tirer de plein fouet à la flottaison; si le coup est un peu bas, le ricochet l'amène sur le bâtiment. Ne tirer dans les manœuvres qu'avec des fusils de rempart. On ne fait plus usage du tir à boulets rouges. Si l'on a affaire à plusieurs bâtiments, diriger toutes les pièces de la batterie sur celui qui se trouve le plus à portée.

Connaître exactement les distances de tous les points remarquables, et l'afficher dans le magasin au matériel et dans le corps de garde, afin de pouvoir évaluer celles des bâtiments.

* = 32 English. † = 8·661 inches English. ‡ = 12·6 inches English.

Pointer une bouche à feu de but-en-blanc sur la ligne de flottaison et la faire tourner ainsi pointée sur sa plate-forme horizontale, pour rapporter la direction du rayon visuel à des objets de la côte dont les distances sont connues; avoir égard dans cette opération à la hauteur actuelle de la mer.

Observer les ricochets sur l'eau.

Tirer à balles sur les débarquements.

Tenir en barils ou caisses, derrière l'abri de la batterie, 4 charges par bouche à feu, quelques projectiles empilés à gauche et en arrière de leurs bouches à feu, les bombes et obus l'œil en bas; les boute-feu allumés en nombre suffisant.

Se garder avec soin contre les surprises, surtout la nuit; observer tout ce qui se montre en mer ou sur la côte; être attentif à tous les signaux.

Veiller à la conservation du matériel avec tous les soins convenables; aérer les magasins dans les temps secs; faire mouvoir tous les jours les châssis d'affût.

Les obusiers de campagne ou de montagne sont destinés à agir contre les débarquements; les enterrer à demi, s'il est possible, près du rivage, donnant un feu rasant et prenant les chaloupes en flanc. Ils tirent à obus contre les embarcations, à balles contre les troupes débarquées.

Nombre d'hommes nécessaires au service des diverses bouches à feu.

Canons de siége	7 hommes.	Mortiers de 22c et 15c . .	3 hommes.
Obusiers de siége . . .	5 „	Pierriers	5 „
Can. sur affût de pl. et côte	5 „	Bouches à feu de campagne	8 „
Mortiers de 32c et 27c . .	5 „	Obusiers de montagne . .	6 „

In addition to the above, and to the suggestions in the text as to the heights of batteries above the sea level, the following, from the same work, is given as laying down an important principle.

"Nous croyons qu'il convient d'établir des principes qui ne sont pas encore assez connus, sur l'emplacement des batteries de côte. Les boulets ricochent sur l'eau mieux que sur terre, et tous les ricochets, sous 2 ou 3 degrés, font perdre peu de force aux gros boulets. Ceux de 24, sous 4 degrés, conservent encore plus de force qu'il ne faut pour perçer le flanc d'un vaisseau, tel fort qu'il soit, à 300 toises et plus; ainsi toute batterie qui, par son peu d'élévation, sera exposée à l'égoût des ricochets d'un vaisseau, recevra tous ses coups traînans qui lui feront encore beaucoup de mal; et toute batterie qui sera assez élevée pour tirer à bonne portée sur un vaisseau, sous l'angle de 4 à 5 degrés, lui fera tout de mal possible, puisque les boulets traînans de la batterie iront tous au vaisseau; mais ceux partant du vaisseau, qui est plus bas que la batterie, ne pourront ricocher assez haut pour monter jusqu'à elle, si elle a la hauteur supposée ci-dessous."

TABLE I.

Proportion of Ammunition and Stores at 100 *Rounds per Piece, for the Armament of Coast Defences under ordinary circumstances.*

Stores, &c.	8-inch gun.	56-pounder.	32-pounder.	24-pounder.	18-pounder.	12-pounder.	10-inch howitz.	8-inch howitz.	$5\frac{1}{2}$-inch howitz.	13-inch mortar.	10-inch mortar.	8-inch mortar.
Handspikes { common	6	6	6	6	4	4	4	4	4	4	4	4
Handspikes { roller; two for each piece on traversing platforms.												
Handcrow levers, 6 feet; a small proportion in a battery										2	2	2
Iron crows, $5\frac{1}{2}$ feet; ditto										2	2	2
Sponges,* with staves, &c., complete	2	2	2	2	2	2	2	2	2	2	2	2
Staves, sponge, spare	1	1	1	1	1	1	1	1	1	1	1	1
Wadhooks with staves	1	1	1	1	1	1	..	..	..	..	..	..
Ladles, copper, with staves	1	1	1	1	1	1	..	..	..	..	..	..
Cartouches, leather, large	1	1	1	1	1	1	1	1	1	1	1	1
Clippers, portfire	1	1	1	1	1	1	1	1	1	1	1	1
Hammers, claw, small	1	1	1	1	1	1	1	1	1	1	1	1
Heads, spare { rammer	1	1	1	1	1	1	1	1	1	1	1	1
Heads, spare { sponge	1	1	1	1	1	1	1	1	1	1	1	1
Horns, powder	1	1	1	1	1	1	1	1	1	1	1	1
Irons, priming, long, sets	1	1	1	1	1	1	1	1	1	1	1	1
Vent, bits	1	1	1	1	1	1	1	1	1	1	1	1
Linstocks with cocks	1	1	1	1	1	1	1	1	1	1	1	1
Hammers, detonating, with laniards	1	1	1	1	1	1	1	1	1	..	..	..
Hambro' line, skeins	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	..	..	..
Pins, linch, iron, spare	1	1	1	1	1	1	1	1	1	..	..	..
Punches for vents	1	1	1	1	1	1	1	1	1	1	1	1
Spikes, common	2	2	2	2	2	2	2	2	2	2	2	2
Tampions	..	..	..	..	..	..	..	..	..	1	1	1
Thread, pack, in lbs.	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Wads, junk	100	100	100	100	100	100	..	..	..	..	..	..
Ammunition and Laboratory Stores.												
Shot, round, hollow	80	..	..	..	..	..	..	..	..	..	..	..
Shot { round	..	100	80	80	80	80	..	..	..	..	..	..
Shot { case { common	5	..	5	5	5	5	10	10	10	..	..	..
Shot { case { spherical	..	..	5	5	5	5	..	20	20	..	..	..
Shot { grape	..	..	10	10	10	10	..	..	..	..	..	..
Shot { pound, rounds; for mortars, according to circumstances.												
Wooden bottoms for pound shot; ditto												
Shells, common, empty	15	..	..	..	..	..	90	70	70	95	95	100
Carcasses, round, fixed	..	..	..	..	..	..	..	..	..	5	5	..
Cartridges for { charge, flannel or paper, with flannel bottoms	100	100	100	100	100	100	100	100	100	..	..	..
Cartridges for { bursters, flannel { common	15	..	..	..	..	..	90	70	70	..	..	..
Cartridges for { bursters, flannel { spherical	..	..	5	5	5	5	..	20	20	..	..	..
Valenciennes composition, proportions; according to circumstances.												
Gunpowder { large grain, whole barrels 90 lbs. each	$11\frac{1}{2}$	$17\frac{3}{4}$	11	9	$6\frac{3}{4}$	$4\frac{1}{2}$	$10\frac{1}{2}$	6	$2\frac{3}{4}$	17	$7\frac{1}{4}$	$4\frac{1}{4}$
Gunpowder { fine grain, lbs.	1	1	1	1	1	1	..	..	..	..	..	..
Gunpowder { mealed, lbs.	..	..	..	..	..	..	1	1	1	1	1	1

* Add now, the like number of rammers with staves.

TABLE I.—*continued.*

Stores, &c.	8-inch gun.	56-pounder.	32-pounder.	24-pounder.	18-pounder.	12-pounder.	10-inch howitz.	8-inch howitz.	5½-inch howitz.	13-inch mortar.	10-inch mortar.	8-inch mortar.
Fuzes for common shells	17	..	..	..	..	..	100	77	77	105	105	110
Fuzes for spherical case shot, cut, L '3	..	..	5	5	5	5	..	20	20	..	..	..
Fuzes for spherical case shot, cut, D '4	..	..	5	5	5	5	..	20	20	..	..	..
Fuzes for spherical case shot, cut, E '5	..	..	5	5	5	5	..	20	20	..	..	..
Fuzes for spherical case shot, uncut	..	..	5	5	5	5	..	20	20	..	..	..
Portfires	6	6	6	6	6	6	6	6	6	6	6	6
Tubes, brass, fixed*	60	60	60	60	60	60	60	60	60	60	60	60
Match, slow, yards	4	4	4	4	4	4	4	4	4	4	4	4
Match, quick, lengths	30	..	10	10	10	10	180	180	180	190	190	200
Augers, fuze	..	..	1	1	1	1	..	1	1	..	..	..
Barrels, budge	..	..	..	..	..	..	..	..	..	1	1	1
Boxes, tin, with straps for fuzes, black	..	..	1	1	1	1	..	1	1	..	..	..
Boxes, tin, with straps for fuzes, blue	..	..	1	1	1	1	..	1	1	..	..	..
Bags, canvas, with straps for fuzes, striped	..	..	1	1	1	1	..	1	1	..	..	..
Bags, canvas, with straps for fuzes, yellow	..	..	1	1	1	1	..	1	1	..	..	..
Boxes, tube (in pockets, leather)	1	1	1	1	1	1	1	1	1	1	1	1
Compasses, pairs	..	..	..	..	..	..	1	1	1	1	1	1
Engines for drawing fuzes	..	..	..	..	..	..	1	..	..	1	1	..
Files, 3-square	1	1	1	1	1	1	1	1	1	1	1	1
Funnels, shell	1	1	1	1	1	1	1	1	1	1	1	1
Funnels, for loading mortars	..	..	..	..	..	..	..	..	..	1	1	1
Hooks, shell, hand, pairs	..	..	..	..	..	..	2	..	..	2	2	..
Hooks, shell, beam	..	..	..	..	..	..	2	..	..	2	2	..
Knives, cutting	1	1	1	1	1	1	1	1	1	1	1	1
Mallets and setters	1, 2	..	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2
Measures, copper, for powder, 4 lbs. to 1 oz., sets	1	1	1	1	1	1	1	1	1	..	..	..
Needles, laboratory	2	2	2	2	2	2	2	2	2	..	..	..
Perpendiculars	..	..	..	..	..	..	1	1	1	1	1	1
Pincers, fuze, iron, pairs	1	1	1	1	1	1	1	1	1	1	1	1
Plummets, lead	..	..	..	..	..	..	..	..	..	1	1	1
Quadrants, brass	..	..	..	..	..	..	1	1	1	1	1	1
Diagonal scales	..	..	..	..	..	..	1	1	1	1	1	1
Saws, tenon	1	1	1	1	1	1	1	1	1	1	1	1
Scissors, pairs	1	1	1	1	1	1	1	1	1	1	1	1
Scales, copper, with beams, pairs	..	..	..	..	..	..	..	..	..	1	1	1
Scrapers, for shells	..	..	..	..	..	..	1	1	1	1	1	1
Screws for drawing corks	1	1	1	1	1	1	1	1	1	1	1	1
Sticks, portfire	2	2	2	2	2	2	2	2	2	2	2	2
†Sheep skins	..	..	..	..	..	..	..	..	..	1	1	1
Thumbstalls	2	2	2	2	2	2	2	2	2	2	2	2
Tongs for placing shells‡	..	..	..	..	..	..	1	1	..	..	..	..
Weights, brass, 4 lb. piles	..	..	..	..	..	..	..	..	..	1	1	1
Worsted, oz.	1	1	1	1	1	1	1	1	1	..	..	..

* Add 120 detonating tubes for each gun or howitzer.

† Tangent scales, wood, 1 for each gun or howitzer.

‡ Bearers, &c., for carrying hot shot, are considered as belonging to the Furnace Equipment.

TABLE II.

Shewing the principal Heights of the Guns of Shipping above the water.

Rate.	Class.	Height of quarter-deck above the sea.		Height of gun-deck above the sea when it carries guns.		Height of main-top above the sea.		Remarks.
		ft.	in.	ft.	in.	ft.	in.	
1st	120	26	0	4	0	89	0	Main-top large enough to carry a carronade.
,,	104	25	6	3	10	87	6	
2nd	90	19	6	5	0	86	0	
,,	84	19	6	5	0	86	0	
,,	80	19	9	5	0	86	3	
3rd	74	18	10	4	0	78	6	
Razee	50	14	0	7	0	77	6	
,,	,,	15	6	8	0	80	0	
Frigates, Corvettes, and Brigs.	36	13	6	6	6	71	0	
	44	11	8	5	0	69	0	
	26	12	3	5	6	64	6	
	28	11	6	3	3	52	6	
	18	—		6	0	52	0	
	,,	—		6	0	52	0	
	16	—		5	0	52	6	
	,,	—		5	3	51	6	
	10	—		5	9	48	6	
Steamer		—		11	9	79	0	
,,		—		11	3	72	6	
,,		—		9	6	60	6	
,,		—		6	2	42	8	

Column 4.—The great variation in heights, as given in this column, arises from the difference between the old and new principles of construction, in which last it is a main point to keep the guns as high out of water as possible.

Column 5.—Given in consequence of the effect produced at Algiers in enfilading (at close quarters) a previously troublesome battery by hoisting a carronade into the main-top of a line-of-battle ship that from its position was thus enabled to rake the work most effectually.

DEFILADE.

In Plan—the direction given to the faces of a work, so as to avoid enfilade, and being taken in reverse.

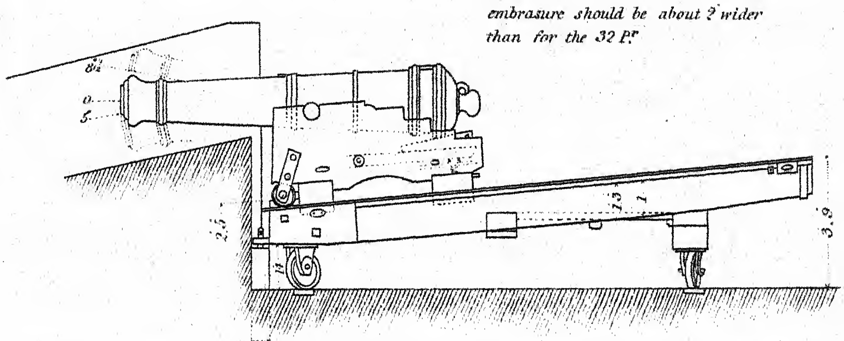
In Section—and with reference to Permanent Fortification, it implies the arrangements for preventing unnecessary exposure of the exterior and interior of works: to carry out both in conjunction is frequently an anomalous task.—*See* 'Command,' p. 230; and vol. ii., to which this part of 'Defilade' properly belongs.

In Section—and with regard to Field Fortification, where exposure of the escarp is in general of little consequence, the task is comparatively simple *as far as it is practicable;* for, with the utmost skill, it will at times become a problem admitting only of a partial solution.

DWARF WOODEN TRAVERSING PLATFORM.

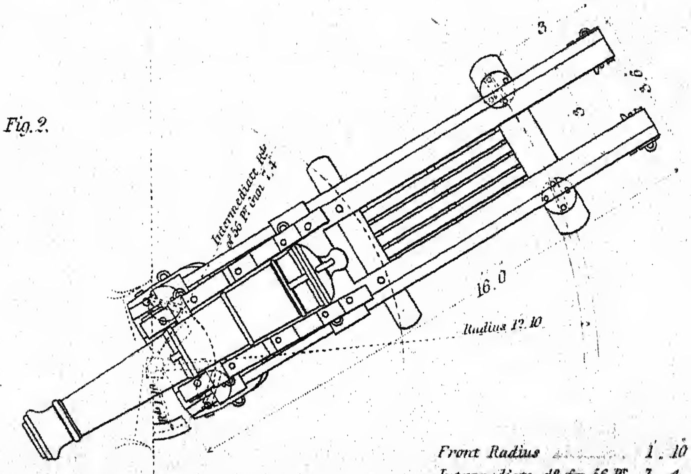
M.G. & B.O. 1 April 1846, superseding that of 6 May 1844 & 15 Dec.r 1845 Applicable from 8 inch Gun of 65cwt to 18 P.r inclusive.
The Platform for the 56 P.r is 4 feet wide; for this Gun the neck of the embrasure should be about 2" wider than for the 32 P.r

Fig. 1.



The Slides of S.S heavy Pivot Guns are in width between the sides the same as the Dwarf Platform for Guns to 65cwt inclusive; and Land, or S.S Carriages may be worked on either. For Guns above 65cwt the Dwarf Platform is 5 inches wider; but S.S Carriages may be worked upon it by lining up the front and hind blocks to the additional space between the sides.

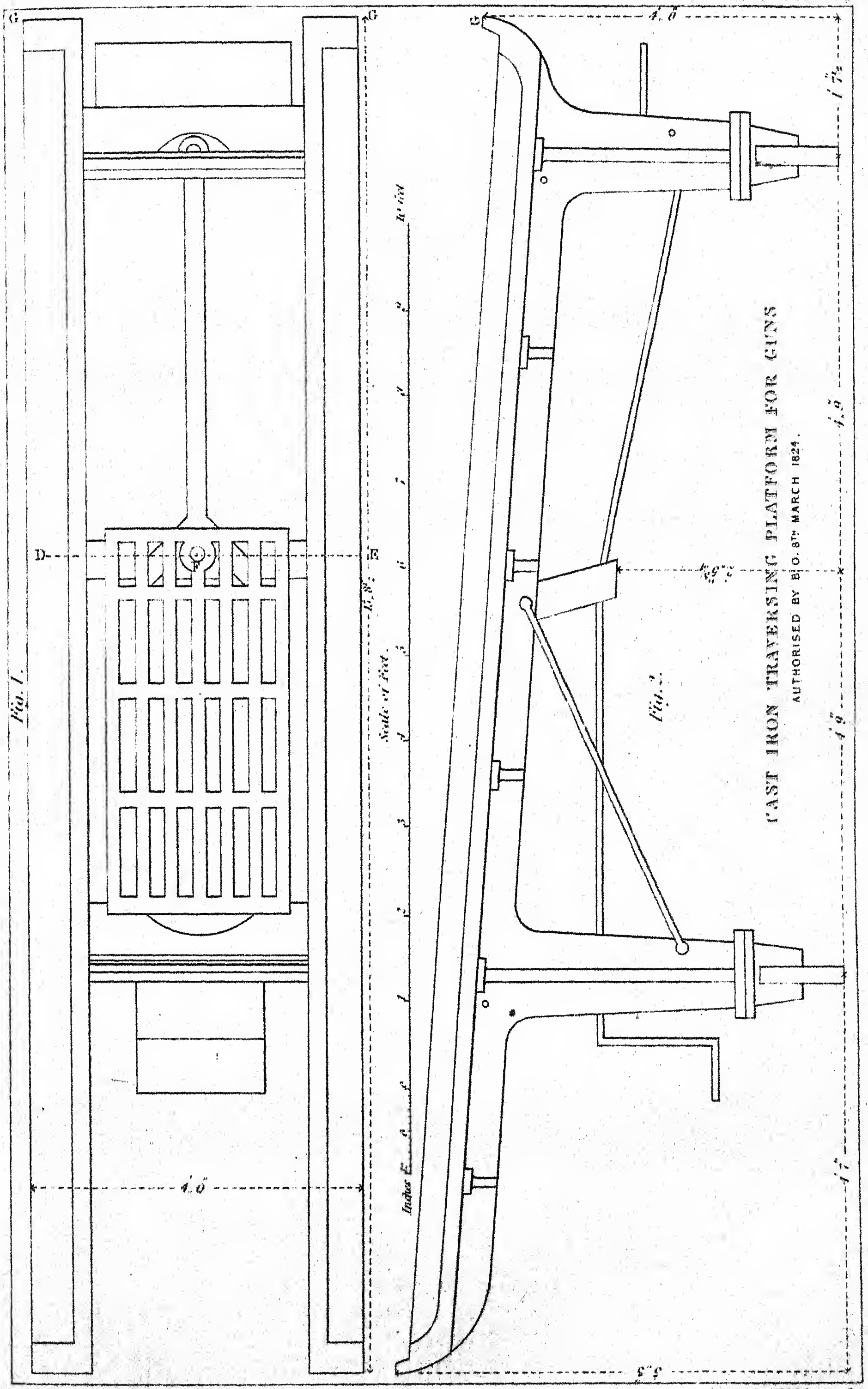
Fig. 2.



Front Radius	....	1 . 10
Intermediate d.o for 56 P.r		7 . 4
Rear Radius	....	12 . 10

C. Rosenberg, sc.

John Weale, 59, High Holborn, 1846.

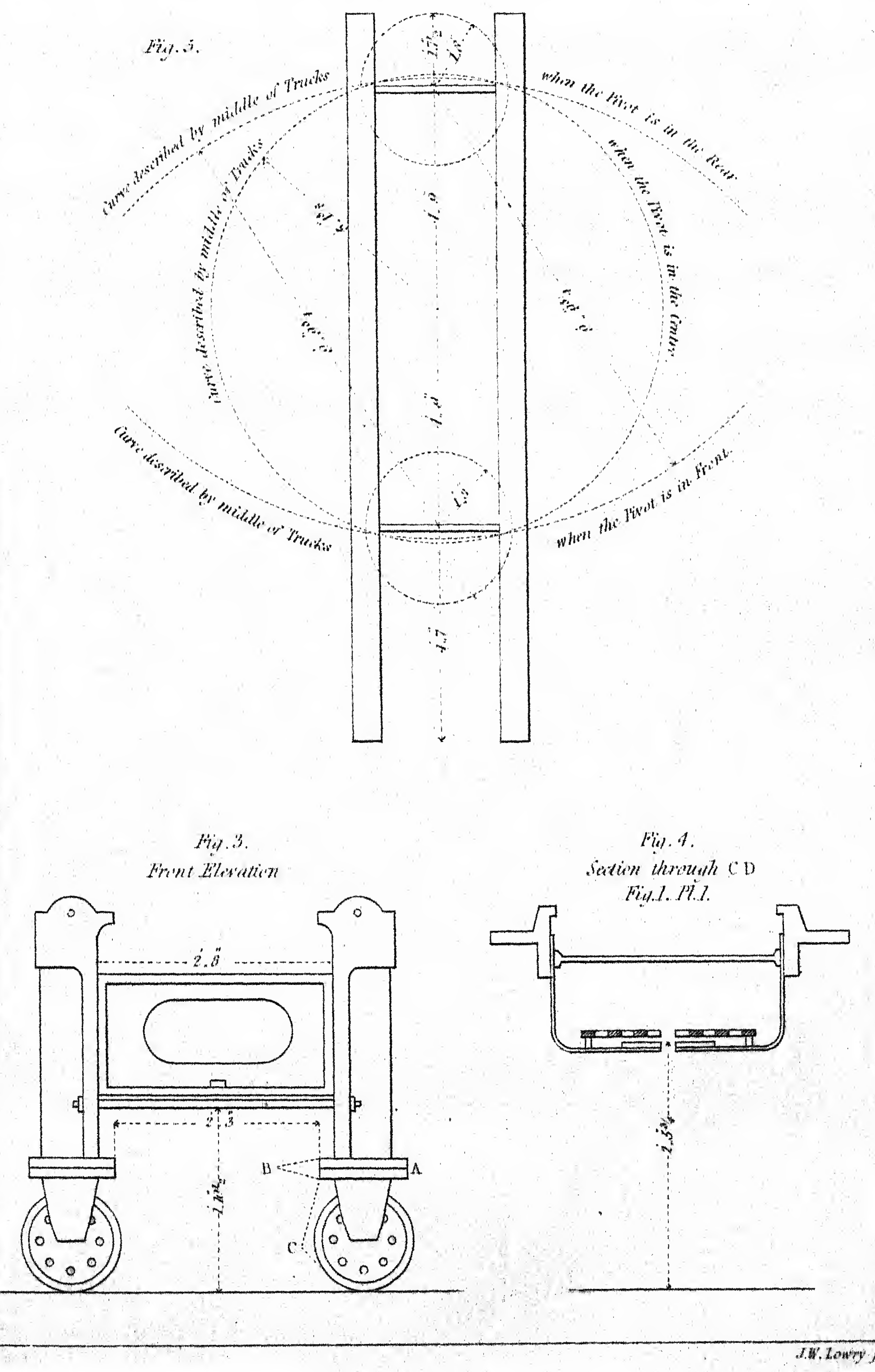


J.W. Lowry fc.

John Weale, 59, High Holborn, 1846.

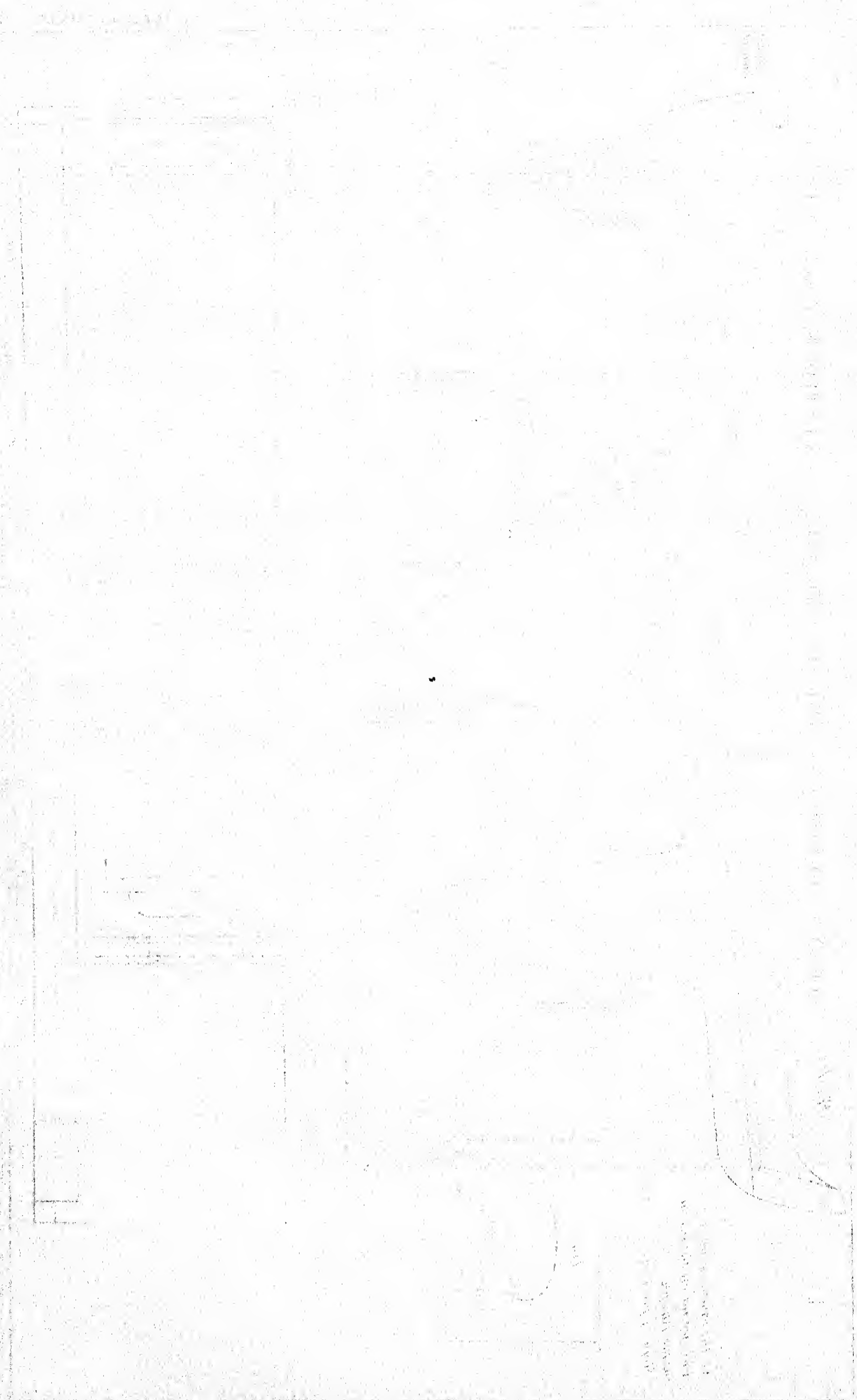
DIAGRAM OF THE CENTRAL LINES OF THE IRON RACERS,

WHEN IN FRONT__CENTRE __OR REAR

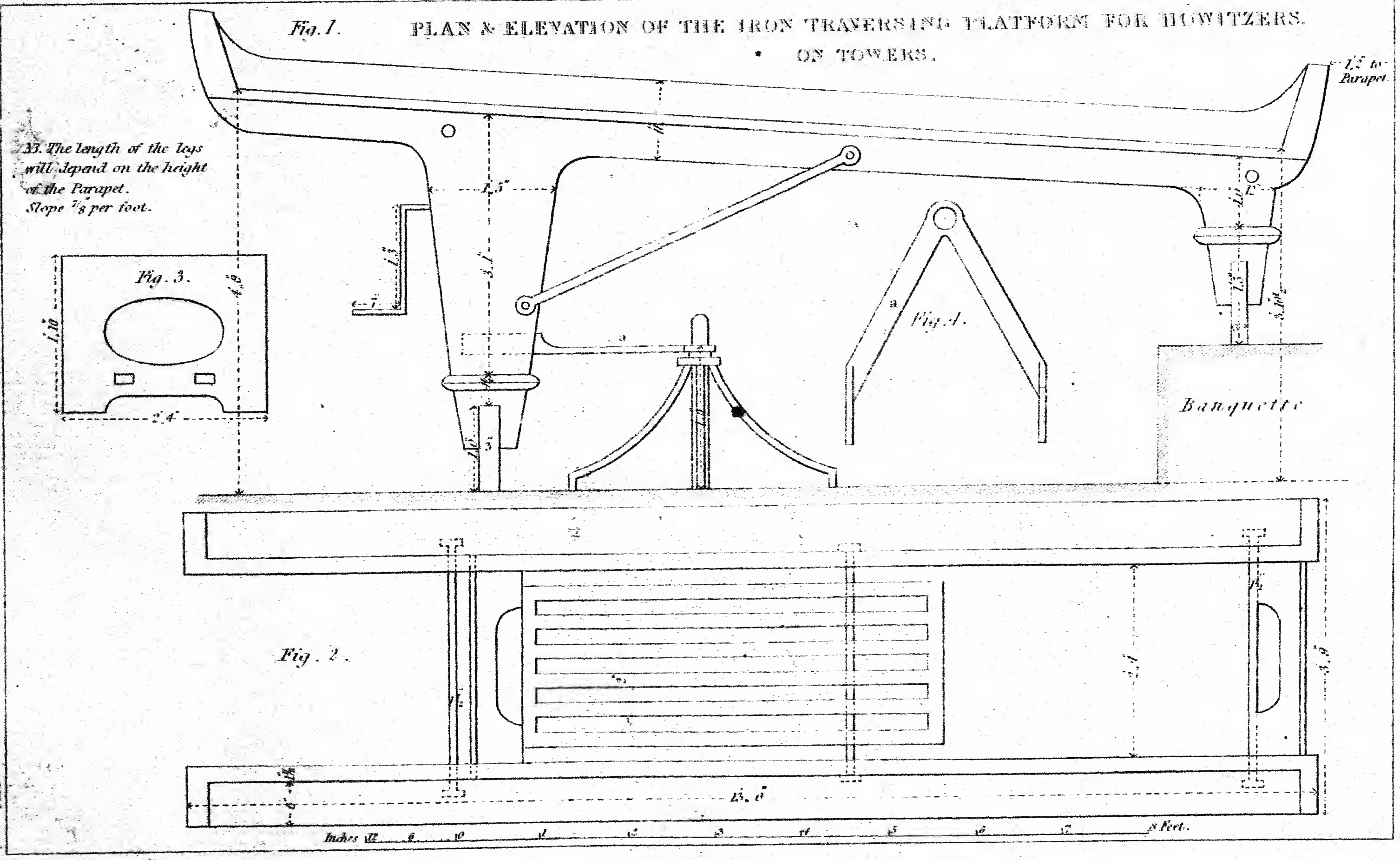


J.W. Lowry fc.

John Weale, 59, High Holborn, 1846.



PLAN & ELEVATION OF THE IRON TRAVERSING PLATFORM FOR HOWITZERS. ON TOWERS.

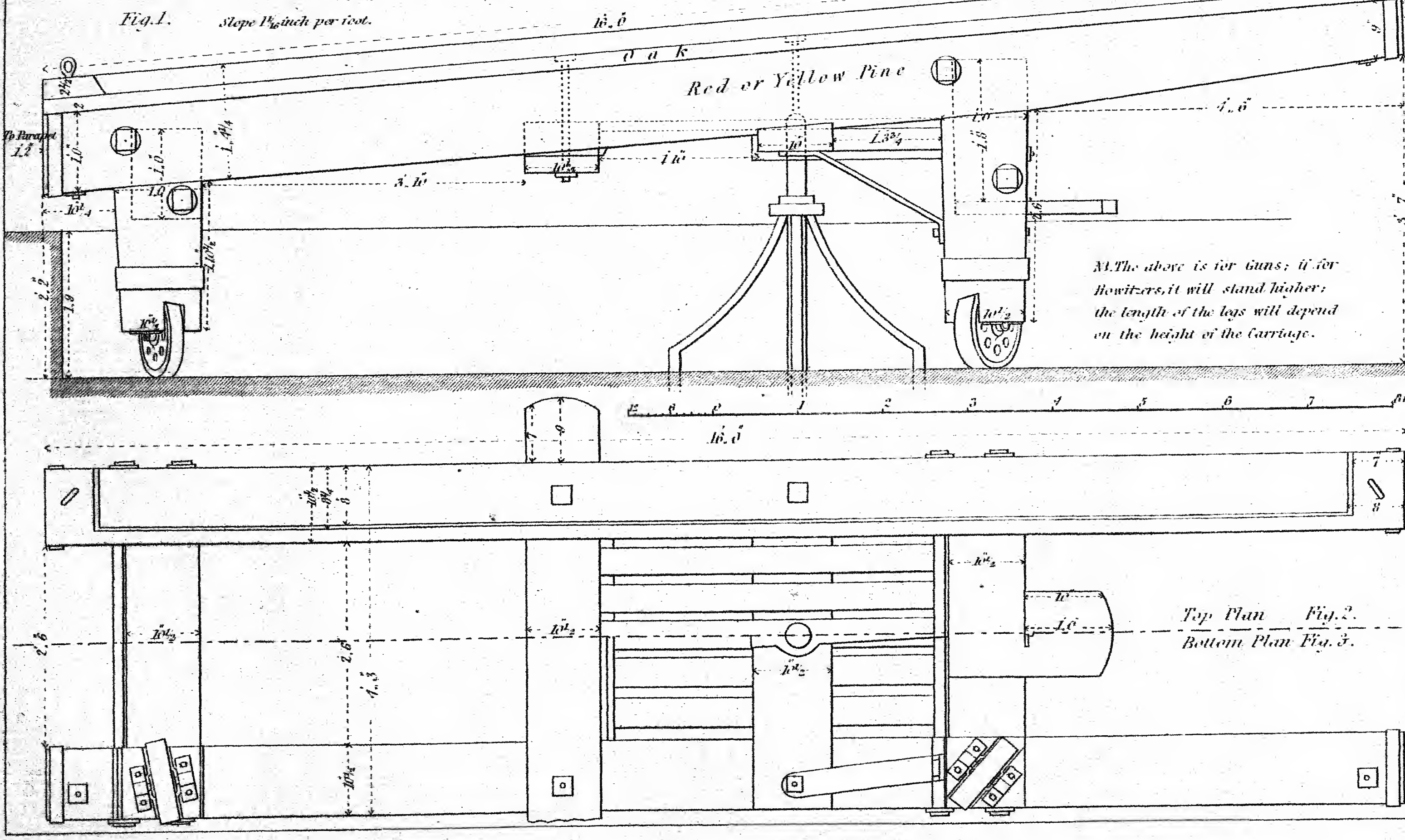


N.B. The length of the legs will depend on the height of the Parapet. Slope 7/8 per foot.

T.W. Lowry fc.

PLATFORM FURNISHED TO THE CIRCULAR TOWERS IN ENGLAND

AS ADAPTED TO A 6 FT PARAPET IN A 20 FT DIAMETER TOWER



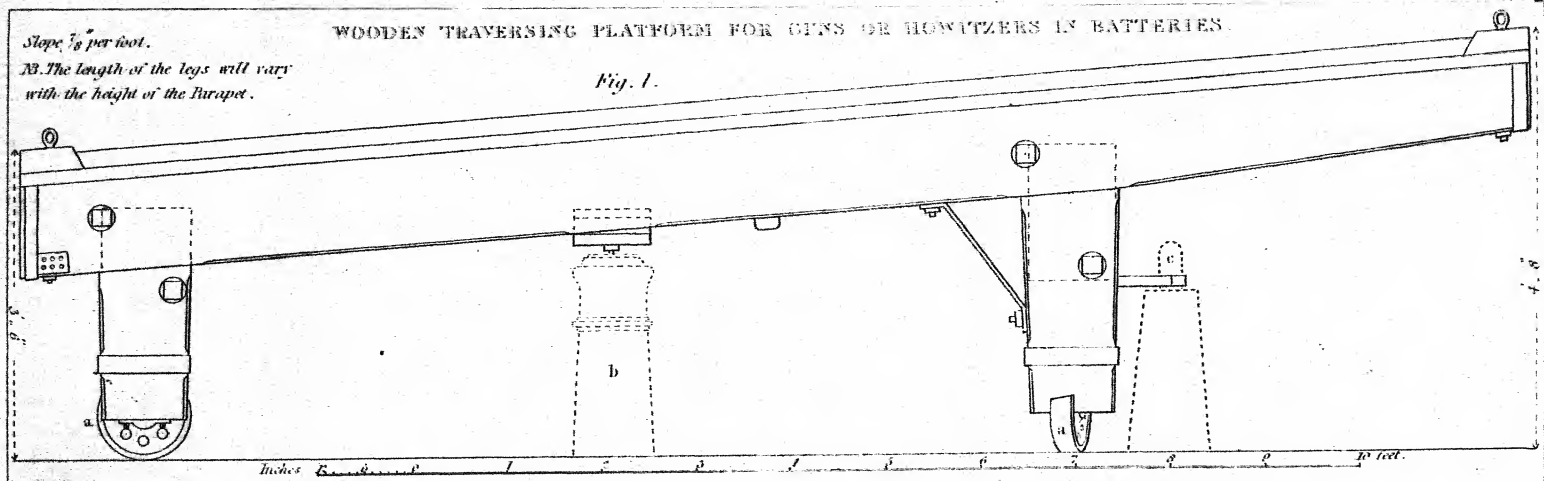
John Weale, 59, High Holborn, 1846.
J. W. Lowry fc.

WOODEN TRAVERSING PLATFORM FOR GUNS OR HOWITZERS IN BATTERIES.

Slope $\frac{7}{8}$" per foot.

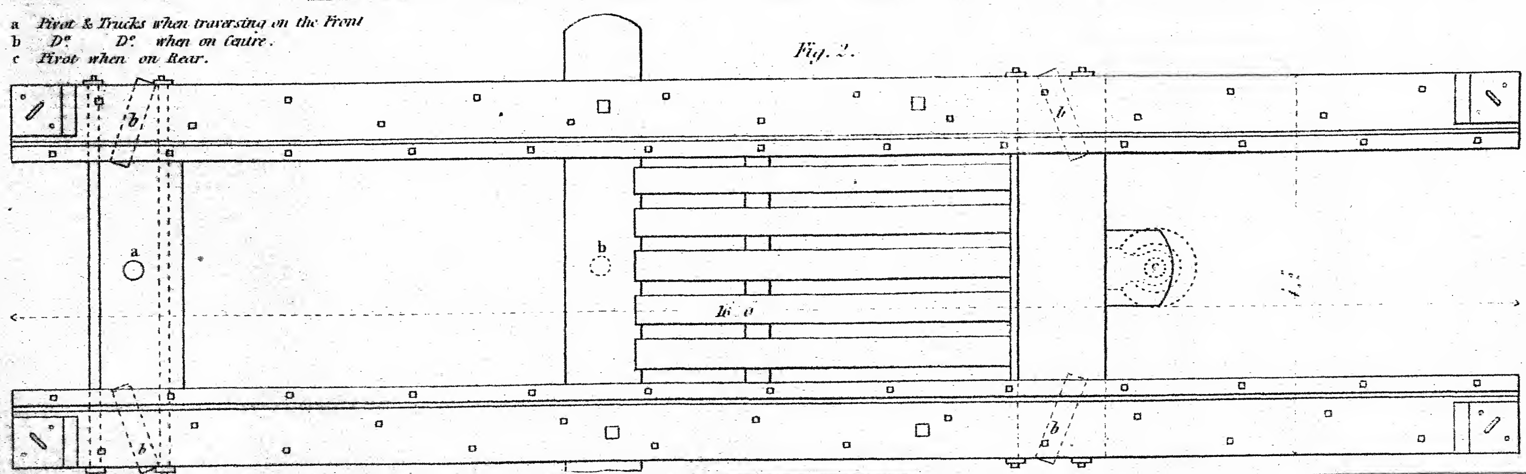
N.B. The length of the legs will vary with the height of the Parapet.

Fig. 1.



a Pivot & Trucks when traversing on the Front
b Do. Do. when on Centre.
c Pivot when on Rear.

Fig. 2.



J. W. Lowry fc.

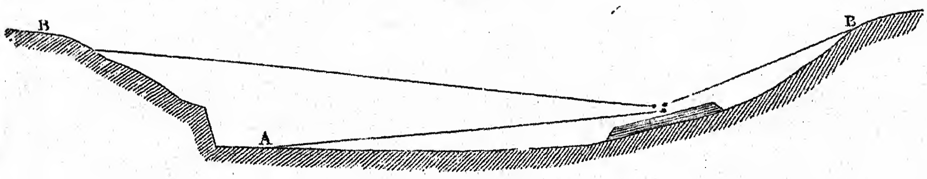
John Weale, 59, High Holborn, 1846.

To defilade a Field-work, then, is merely so to arrange the heights of the different parts that the enemy may not be able to see into it; and this is more appropriately and expeditiously effected by the eye and a few poles and profiles, than by resorting to theoretical and scientific proceedings,—though these last are generally indispensable in considerations of Permanent Fortification.

Defilade in plan requires no comments: as to that in section, works should be defiladed against musketry within 400 yards; and against artillery, within 1200 yards; for although this may be considered random practice, it will nevertheless keep the garrison in a state of constant disquietude.

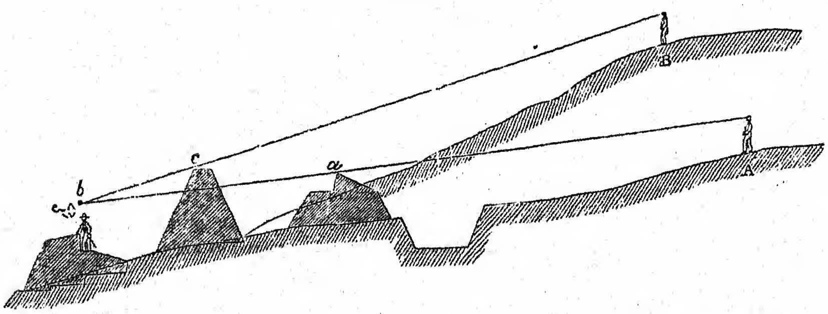
A work may require defilade either from a plain (A, fig. 1) below it; or from a height or heights (B) above it; or from a height or heights (A, fig. 6) adjacent.

Fig. 1.



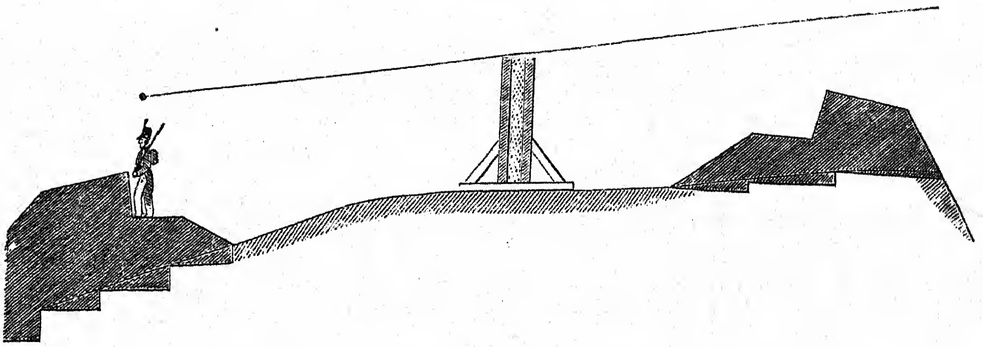
With regard to fig. 1, and exposure from A or B, in either case the nearest parapet to the enemy (*a*, fig. 2) must be, as far as possible, able to screen the space to be concealed, so that the line of fire (A *a*) may not go less than about 3 feet over the head of the man (*b*) on the opposite side of the work. If this cannot be done from a

Fig. 2.



too great command, as from B, a parados (*c*) becomes necessary,—still affording an equal cover to *b*, though leaving much of the space (*a c*) unprotected. In case of defilade from musketry only (fig. 3), the parados may be of two rows of plank and earth between, or of timber only: the scantling may in some degree depend upon the height, but more on the nature of the wood and the distance from the enemy.—*See* 'Barricade,' p. 130, and 'Penetration.'

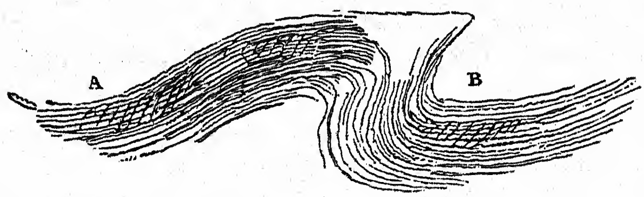
Fig. 3.

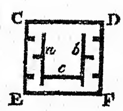


When the other lines of the work are liable to enfilade, either from the plain below or the heights above or adjacent, the best application of traverses must be made that circumstances will permit.*

Thus far relates to the simplest case—that of defilade against a single height; and with the simplicity, it often happens that the complete practicability disappears. The problem becomes more or less difficult when it has reference to more heights (A, B, fig. 4) than one, more or less surrounding a work as well as commanding it.

Fig. 4.



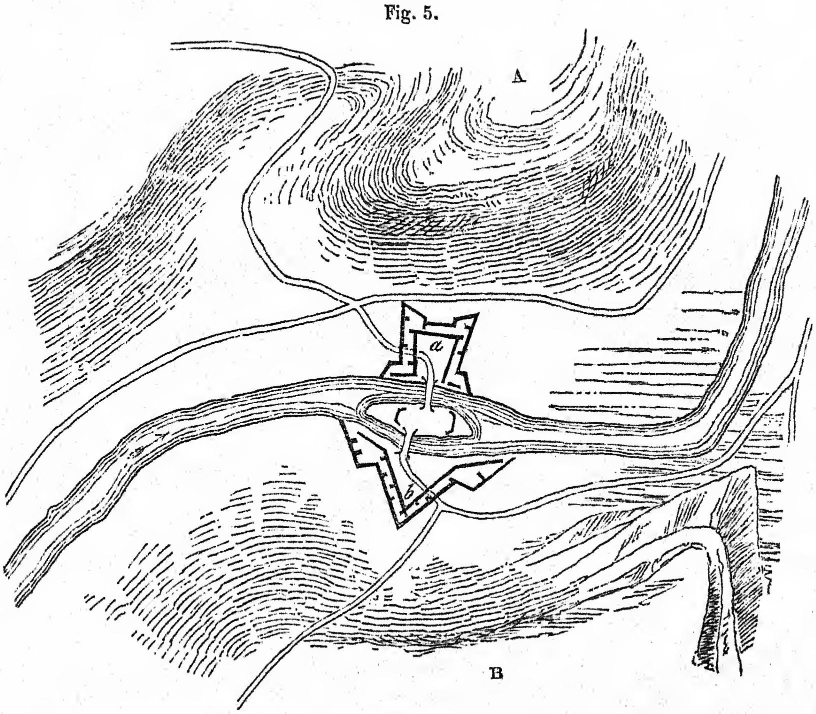


Thus, to prevent EF, CE, DF, from being taken in reverse from AB, the parados (*a*, *b*, *c*) are as indispensable as the traverses along CE DF, to give some protection from enfilade.† And in fig. 5, where an old bridge has to be secured at all risks, at the

* Several of these figures are somewhat caricatured, from want of space to give them in true proportion.

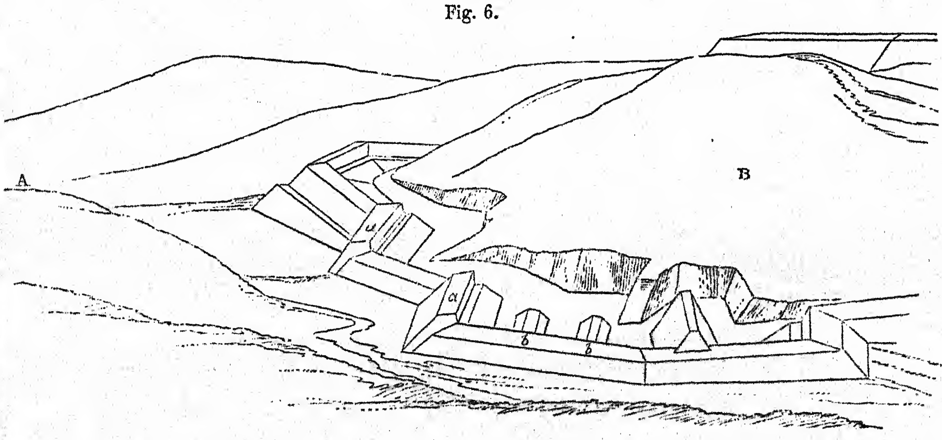
† Placed as C D E F is with regard to A and B, one side is taken in reverse, and two are enfiladed; but it would be still worse to turn the salients towards the hills, for then two sides would be seen in reverse, and the rest enfiladed. Hence, in such cases, a face should be presented to the enemy rather than an angle. If the work be an oblong, a long side should be turned towards A and B rather than a short one, as the defilade becomes easier thereby. With regard however to such a case as fig. 5, it matters little whether the work presents the front *a* to A, or the salient *b* to B. What would be an advantage under other circumstances in having such a front as *a*, is here rendered almost nominal by the direct fire from A, and that in reverse from B.

Fig. 5.



mouth of a valley, of which the two sides (A, B) cannot be kept free from the enemy, — it seems that nothing remains to be done but to double the works by the two conformable parados (a, b), in addition to such traverses as may be necessary. It is true that neither of these positions are of common occurrence, and would be very objectionable were it practicable to avoid them; but such instances are within the limits of possibility, and illustrate the case where complete defilade is out of the

Fig. 6.



question, and where works become so encumbered* with traverses and parados to effect it, as to lose much of their efficiency. With reference to fig. 6, (in which it is also to be supposed that so very objectionable a tracing has been unavoidable,) defilade becomes of little use to the parts above, or on a level with A; and of still less to those below it, although everything possible should be done,—such as raising the shorter faces (*a*, *a*), adding traverses (*b*, *b*), &c. The works and the ground immediately in the rear of *aa*, *bb*, are barely screened; and the interior space (B) remains generally exposed.

"When works are placed within range of heights by which they are commanded, the choice of outline should be principally attended to; for among the different tracings which may be used, some will be much more easily defiladed than others.

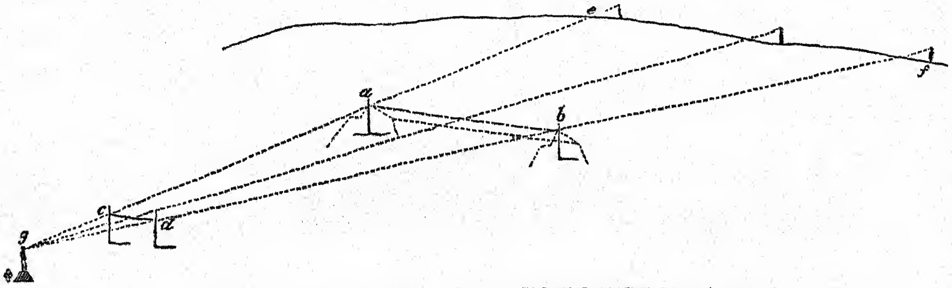
"The choice of a position to be fortified, as well as the particular method of occupying it by continued lines, or by lines with intervals, is therefore a matter of very great importance. If any of the heights commanding a position cannot be occupied, epaulements may then be thrown up, 50 or 60 yards in rear of the lines, to cover the troops intended for their defence.

"It is in general not possible to place all the crests of continued lines in the same plane of defilement; they should then be divided into parts, separated by traverses, each part having reference to its own planes of site and defilement."†

In laying out such a work as shewn in fig. 2, either the height of the crest *a*, or that of $b + 3$ feet, must be assumed to commence with, and as the regulating dimension. If the hill (A) be accessible, then by holding up a pole at *b*, with a short cross-piece marking the intended height of $b + 3$ feet, the line drawn from that point to the height of the eye at A, intersecting a pole at *a*, shews the height of the crest that will cover the man at *b*. In like manner, the height of the parados (*c*) can be determined from B. If, however, the point A (or B) be not accessible, then the height of $b + 3$ feet being marked on the staff, the eye must be raised to look over the cross-piece to see where the height of a man at A (or B) cuts on the pole (*a*), to give the height of the crest of the parapet.

And in the same way that any one point is obtained, any number of the like completing the required form may be determined; and, if raising at one spot exposes the work too much at another, a judicious compromise, so making the best of the matter, is frequently all that can be effected when more than a single hill is to be considered.

Fig. 7.



* Although a parados takes up so much room, yet it may be turned to good account in the formation of blindages.

† From Macaulay's 'Field Fortification.'

It will generally happen when the ground opposite is simple, that a length of line (*a b*, fig. 7) may be defiladed at once by looking along a string (*c d*) parallel to the crest of the hill (*e f*) from a central or other suitable point (*g*), which (as at *b*, fig. 3) must include the extra 3 feet of height.* When the whole work has been thus marked out in elevation by a skeleton of poles and cords, and the defilade has been decided to be as satisfactory as circumstances permit, the profiles may be set up, dressing on the "skeleton of poles and cords," and the work completed according to the usual routine of execution.

The defilade for musketry will do for that of artillery, provided the parapets, parados, and traverses are thick enough.

Fig. 8.

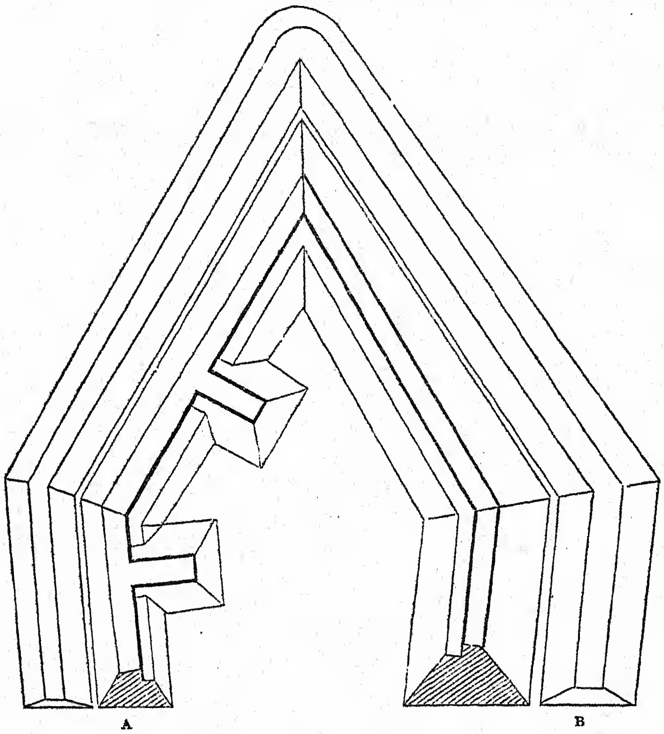
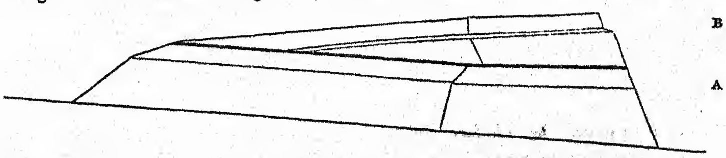


Fig. 9.—Side elevation of fig. 6. (Traverses omitted for the sake of clearness.)



* Some prefer considering the 3 feet as added to *e* or *f*, instead of being thus allowed for at *g*.

If fig. 8 or 10 be a lunette on ground sloping up towards a neighbouring hill in front, with the left face and flank liable to enfilade and reverse from the summit, it will be decided by local circumstances whether the required protection is to be obtained by general defilade of the whole work, and by traverses, as in figs. 8, 9, or by a parados, as in figs. 10, 11, raised sufficiently at *a* to intercept the enfilade,

Fig. 10.

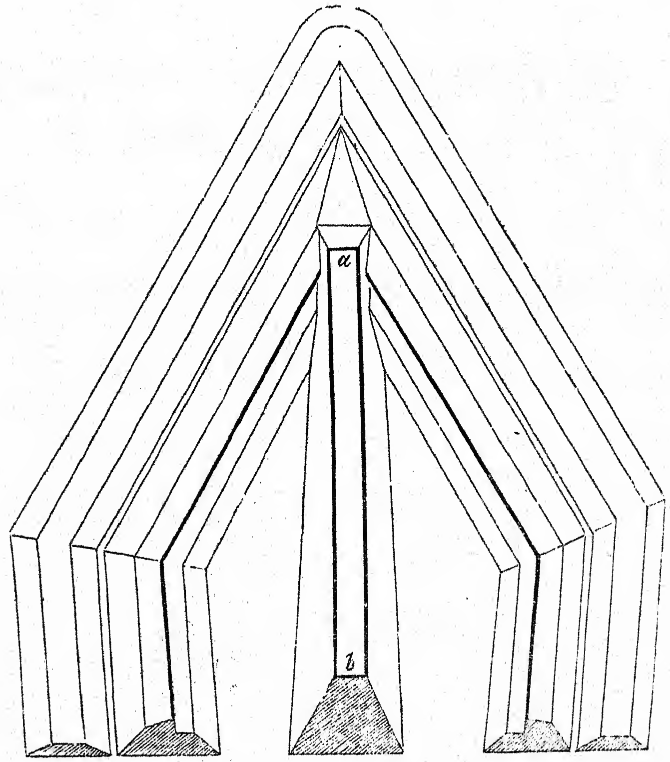
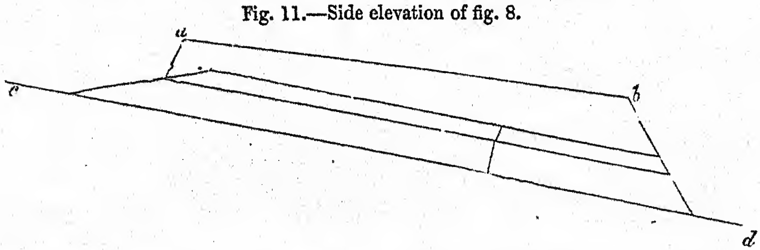


Fig. 11.—Side elevation of fig. 8.

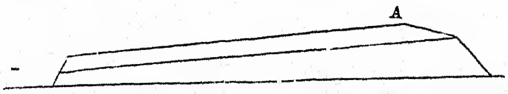


and at *b* to screen the left face and flank from reverse fire, leaving the crest of the parapet parallel to the plane of site (*c d*). If both planes be equally effective, it then remains only a question of time, labour, and material.

Defilade by sinking the interior of a work is on many accounts objectionable.

When the hill in front has no great extent towards the flanks, the interior of a work may be protected by merely elevating the parapet from the rear towards the salient (A. fig. 12).

Fig. 12.



It may be admissible to anticipate two important points in 'Tracing,' in order to simplify the execution of 'Defilade.'

Much time, labour, and profiling stuff will often be saved if the profiles be set up at once on the capitals of the angles, instead of allowing two for each face along its

Fig. 13.

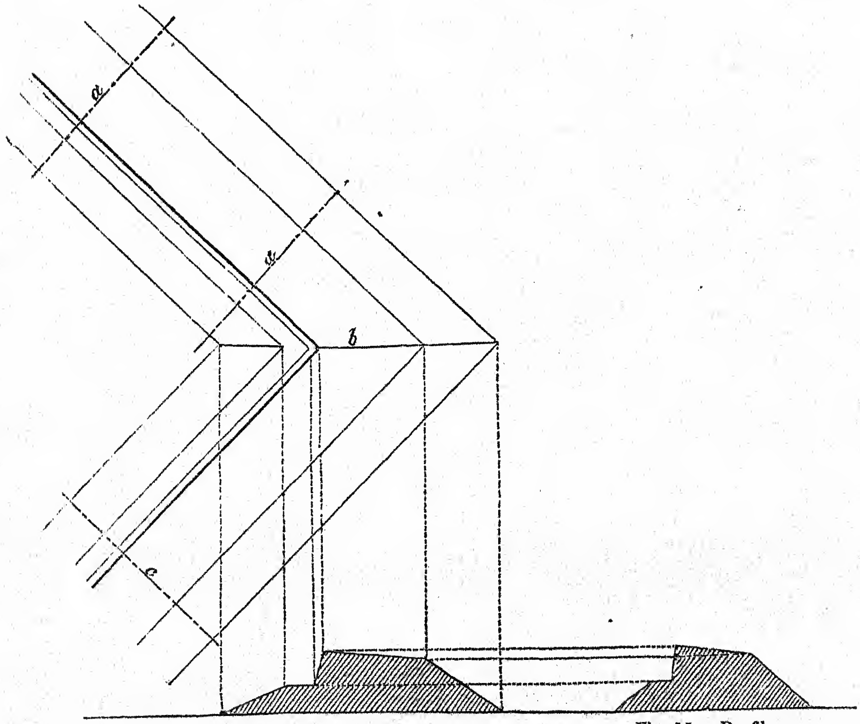


Fig. 14.—Profile *b*. Fig. 15.—Profile *a*.

length. It will require a slight orthographic projection, which, with a little care, a carpenter's rule, and a pencil, can generally be made on the spot. Thus, if *b* (fig. 13) be substituted for *a*, *a* or *a*, *c*, the section will be fig. 14 instead of fig. 15.

Further, much perplexity will also be saved by remembering that the spirit of the tracing lies in the position of the interior crest of the parapet: if this be mainly attended to, the remaining lines, especially the foot of the exterior slope, will *find out their own places* according as the surface of the ground is level or otherwise: unless that surface be a perfect plane, and the crest of the parapet is parallel to it, the only lines that necessarily remain parallel amongst themselves are three; viz. the said interior crest of the parapet, the foot of its interior slope, and the outer edge of the terreplein of the banquette. R. J. N.

DEMOLITION OF WORKS AND BUILDINGS.*

Under this subject we shall confine our observations to the following:

Demolition of Revetments,
Towers,
Magazines,
Military Buildings,
Cisterns,
Bridges,
Barriers,
Booms.

REVETMENTS.

As no certain rules have been arrived at for determining the proper charges for throwing down masonry, we shall offer a few examples where the results have been successful, leaving the Engineer who may be called upon this service to use his judgment, there being a variety of points for consideration before he can determine the quantity of powder necessary to be used.

1st. The section of the wall should be ascertained.

2nd. The nature and quality of the revetment, whether brick or stone; the description of stone, as the weight will be different according to the materials with which the wall is built, as whether rubble, tapia, or ashlar. Climate has a great effect upon masonry: in hot climates, masonry may be considered invariably to be of a much better quality than in cold regions, the mortar being harder, and the work more closely united. It will be necessary to ascertain whether there are counterforts, and if so, the size of them, and the distance they are from centre to centre, as also the materials filled in behind, or backing the wall or revetment: this, in general, may easily be ascertained, but mention is made of it, as a soft or scaly rock, which is liable to be acted upon by frost, is frequently faced with stone or brick, having the appearance of a regular retaining wall. In many cases, the section of a wall cannot be ascertained until the gallery or shaft leading to the intended chamber has been carried down to the foot of the wall: this accomplished, the charges can then be determined.†

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* By Colonel H. D. Jones, R. E.

† The voltaic battery must now be considered as a necessary adjunct in the demolition of works and buildings.

Revetments have been destroyed in a variety of ways, either by piercing a gallery through the masonry from the bottom of the ditch, or by sinking shafts at the back of the revetment. No precise rules can be laid down as to the plan on which the work should be executed, there being different circumstances to be attended to in each case that would require to be fully considered before the Engineer can determine which will be the best mode of proceeding with his work. In general, *time* is an important consideration, greatly regulating the character of the operation; and that which will accomplish the object intended most rapidly, with the smallest expenditure of materials, is the one to be adopted: for instance,—at the destruction of the Spanish lines before Gibraltar, in 1810, several attempts were made to run a gallery from the interior of the work to the back of the revetment; but the sand came in so fast at the head of the gallery, that it at last brought down the terreplein, which occasioned the workmen to abandon this plan, and to adopt that of sinking shafts at the back of the revetment. This is the more usual way, and generally easiest of execution: in most cases the earth at the back of the masonry is so well consolidated as not to require frames for supporting the sides of the shaft.

In the destruction of the Glacière Bastion at Quebec, in 1828, a gallery was driven in from the interior of the work until it met the masonry, when a return was made and continued along the back of the revetment. The nature of the soil was clayey, occasionally mixed with fragments of rock and made ground, which had acquired a considerable degree of compactness. (See Appendix A.)

At Corfu, in May, 1826, to destroy Fort Schulemburg,* galleries were driven in from the face of the revetment to the rear, with returns to the right and left. (See Appendix B.)

At the siege of Burgos, 1812, a gallery was driven in through the face of the wall.

At the destruction of Fort Bourbon, in Martinique, galleries were driven from the face of the revetment through the thickness of the wall.

At Menin, 1744, the same plan was pursued.

At Almeida, in 1810, shafts were sunk at the back of the revetment.

At Sheerness, in 1827, shafts were sunk at the back of the revetment. For details see Appendix C.

The foregoing examples will be sufficient to shew that there is no very exact rule for the guidance of an Officer charged with the duty of demolition; his own judgment must be his best guide. But, as deduced from the preceding and subsequent notices, see Appendix E, and Table VI. included therein.

The following Tables† shew the data upon which the calculation is to be made for the charges of powder in masonry or brick-work, as prepared by Lieut.-General Sir Charles Pasley for the use of the Officers employed at the Military Establishment at Chatham, and for the guidance of the Officers of the Corps of Engineers in general.

See 'Eprouvette.'

* When there is any doubt of the quality of the powder (as there was in this instance), it should be tested by an éprouvette.—*Ed.*

† These Tables are particularly valuable as having been deduced from experiments on excellent old brick-work.—*Ed.*

TABLE I.

*Charges and Effects produced on Masonry or Brick-work.**

To find the quantity of powder in lbs.	Multiply by	With or without counterforts.	Placed at lined intervals, or how.	Produces effects.	Remarks.
Feet.					
LLR^3	$\frac{3}{20}$	Without.	2-lined, placed at the back of a revetment.	Complete but moderate	Greater charges at the same, or the same at smaller intervals, would produce violent demolition.
LLR^3	$\frac{1}{5}$	With.	In the middle of each counterfort, at its junction with the escarp.	Ditto.	Ditto, ditto, ditto, and if from counterfort to counterfort is unusually great in proportion to the thickness of the revetment, place one or more charges between each at the back of the revetment.
LLR^3	$\frac{1}{3}$	——	Centre of a line of masonry at 2-line intervals.	Ditto.	To produce violent demolition, or if obliged to use greater intervals, increase the charge.
LLR^3	$\frac{4}{10}$	——	Under a foundation having equal earth on each side, 2-line intervals.	Ditto.	
LLR^3	$\frac{6}{10}$ or $\frac{1}{2}$	——	Ditto, ditto, if wood-work under foundation.	Ditto.	
LLR^3	$\frac{1}{10}$	——	In centre of mass of masonry, base circular or polygonal.	Ditto.	Use more to avoid chance of failure.

N.B.—Attack a building by the same rules as revetments; or else, merely lay your charges on the ground along one side, and cover them with $2\frac{1}{2}$ the thickness of the wall, with rammed earth.

* Abridged from Lieut.-General Sir C. Pasley's Tract on Military Mines. 1827.

TABLE II.

*Demolition of Walls of Buildings by Blasting.**

L L R is of course $= \frac{1}{2}$ thickness of wall, in feet.

The borer and jumper will always make a hole of rather greater diameter than its own width: take great care therefore as to the true diameter obtained.

Work always at an angle of 45° downwards to $1\frac{4}{10}$ L L R, which will bring you to the centre of the wall. Calculate how much more of the same hole $\frac{1}{4}$ of the proposed charge will fill, and bore so much deeper.

In the following, D = diameter of the hole in inches.
T = thickness of the wall in feet.

When D = T (the best proportion, if circumstances admit), charge in lbs. $= \frac{\text{L L R}^3}{3}$ at 2-lined intervals. Depth of hole should be $1\frac{1}{2}$ L L R.

When D = $\frac{2}{3}$ T, charge in lbs. = $\frac{2}{9}$ L L R^3 at 2-lined intervals. Depth of hole should be $1\frac{3}{4}$ L L R.

When D = $\frac{1}{2}$ T, charge in lbs. = $\frac{1}{8}$ L L R^3 at 2-lined intervals. Depth of hole should be $2\frac{1}{2}$ L L R. Bore the holes, *alternately*, from contrary sides; or else at once bore 2 from opposite sides meeting as a V, or even crossing a little below, somewhat like an X. In each hole put $\frac{1}{8}$ L L R^3; or total charge = $\frac{1}{4}$ L L R^3 at 2-lined intervals.

When D = $\frac{1}{3}$ T, proceed with the same charge as when D = $\frac{1}{2}$ T, but see that the holes from the opposite sides, forming an X, intersect each other well.

In working with smaller borers than this, instead of the V or X, bore 2 holes *close* to and parallel to each other: if needful, they can be thrown into one.

Where economy of powder is an object, break the lower part of the wall into piers, and place the charges in them.

TABLE III.

Table of Cylindrical Holes and Charges.

Diameter.	Powder in 1 inch of hole.	Depth of hole to contain 1 lb. powder.
inches.	ounces.	inches.
1	0·419	38·197
$1\frac{1}{2}$	0·942	16·976
2	1·676	9·549
$2\frac{1}{2}$	2·618	6·112
3	3·77	4·244
$3\frac{1}{2}$	5·131	3·118
4	6·702	2·387
$4\frac{1}{2}$	8·482	1·886
5	10·472	1·528
$5\frac{1}{2}$	12·671	1·263
6	15·08	1·061

* Abridged from Lieut.-General Sir Charles Pasley's Tract on Mines. 1827.

TABLE IV.

Table of Spaces occupied by certain Charges of Gunpowder.

Space.	Charge.	Space.	Charge.	Space.	Charge.	Space.	Charge.
Side of cube in inches.	Gunpowder in lbs.	Side of cube in inches.	Gunpowder in lbs.	Side of cube in inches.	Gunpowder in lbs.	Side of cube in inches.	Gunpowder in lbs.
1	0·033	19	228·63	37	1688·43	55	5545·83
2	0·26	20	266·66	38	1829·06	56	5853·86
3	0·90	21	308·70	39	1977·30	57	6173·10
4	2·13	22	354·93	40	2133·33	58	6503·73
5	4·16	23	405·56	41	2297·36	59	6845·96
6	7·20	24	460·80	42	2469·60	60	7200·00
7	11·43	25	520·83	43	2650·23	61	7566·03
8	17·06	26	585·86	44	2839·46	62	7944·26
9	24·30	27	656·10	45	3037·50	63	8334·90
10	33·33	28	731·73	46	3244·53	64	8738·13
11	44·36	29	812·96	47	3460·76	65	9154·16
12	57·60	30	900·00	48	3686·40	66	9583·20
13	73·23	31	993·03	49	3921·63	67	10025·43
14	91·46	32	1092·26	50	4166·66	68	10481·06
15	112·50	33	1197·90	51	4421·70	69	10950·30
16	136·53	34	1310·13	52	4686·93	70	11433·33
17	163·76	35	1429·16	53	4962·56	71	11930·36
18	194·40	36	1555·20	54	5248·80	72	12441·60

"In respect to the comparative effects of gunpowder upon masonry and common earth, it is sufficiently obvious that there are some particulars in which there can be no possible analogy between the two substances; as for instance, no modification of common earth whatever can be compared with the walls of a lofty building. But, in those cases in which some analogy does exist, as, for example, in comparing the effects of gunpowder behind the back of a revetment with its effects when acting below the surface of any mass of common earth capable of retaining its form permanently without being revetted, our experiments at this place do not authorize us to say that more powder is required to produce a like effect upon masonry than upon earth; nor does it appear from our experiments that more powder is required to produce a similar effect upon very stiff compact soil than upon looser earth."—*Lieut.-General Sir C. Pasley's Tract on Mines.* 1827.

TABLE V.

The Table of Charges used by the French for demolition in masonry is herewith inserted, more particularly as it appears to have been based upon the result of experiments made for that purpose, and which were found very accurate whenever tried.

Description of masonry.	Quantity of powder for A toise* cube.	Quantity of powder for A double metre cube.†
	lbs.‡	Kilogrammes.§
New, or old, masonry built or become damp where mortar is bad	15 to 16	7·94 to 8·47
Masonry of an ordinary description where the mortar is not of the best quality . . .	18 to 19	9·53 to 10·05
New masonry, very good, and the mortar excellent	27	14·30
Old masonry, same description	30	15·89
Roman masonry, or equally solid	35	18 33

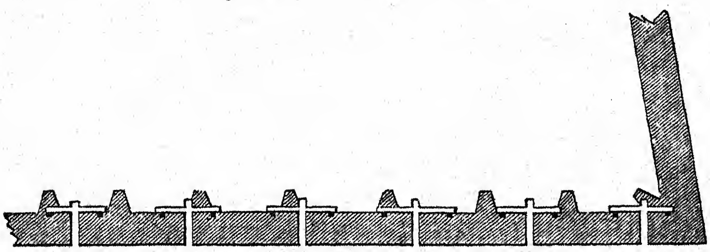
* A toise is 6 ft. 4·735 in. English measure.
† A metre is 3 ft. 3·371 in. English measure.
The cubic toise = 9·684 cubic yards; and the double metre cube is about 10½ cubic yards English.
‡ French lb. = 1·08 lb. avoirdupois. § Kilogramme = 2·206 lbs. avoirdupois.

The preceding charges will be found rather greater than those given by Landmann in his 'Treatise on Mines,' calculated upon the data supplied by French authors: it will therefore be safer and best to use charges calculated according to Lieut.-General Sir C. Pasley's Table; but as it is always interesting to know what has actually been performed, a few examples are given.

1. At Turin the face of a bastion was blown up by gunpowder.

The height of the revetment was 32 feet, the length of the face was 318 feet, the supposed thickness of the wall at the level of the bottom of the ditch was 7 feet 6 inches, the counterforts were 3 feet thick and unequally placed; no notice was taken of them in determining the position of the charges: upon piercing the wall it was found to be only 7 feet thick; the masonry was found to be of the best quality: the charges were 97 lbs., which was rather more than the quantity ought to have been, if calculated at $\frac{97}{343}$, or nearly $\frac{2}{7}$ L L R^3: the demolition was perfect; all the charges were fired simultaneously.

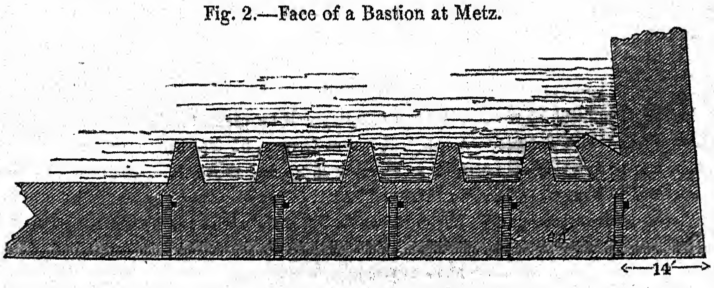
Fig. 1.—Face of a Bastion at Turin.



2. Face of a bastion at Metz.

The revetment was 16 feet thick at the level where the charges were placed; but as it was desired to have the line of least resistance only 12 feet towards the ditch, and to have it much greater in every other direction, the first charge was placed at 14 feet from the salient angle, the second 24 feet from the first, and the same distance was observed with respect to the others as far as the orillon. A gallery was driven in from the face of the wall for each charge, and when at the proper distance, the charge was placed on the right-hand side of the end of each: by this mode the craters would be tangents to each other. The charges were 20 lbs. for each toise cube, and being fired simultaneously, the revetment and counterfort fell down in large blocks: the demolition in both cases being proved equally certain, the mode to be adopted depends upon the time, or men at command.

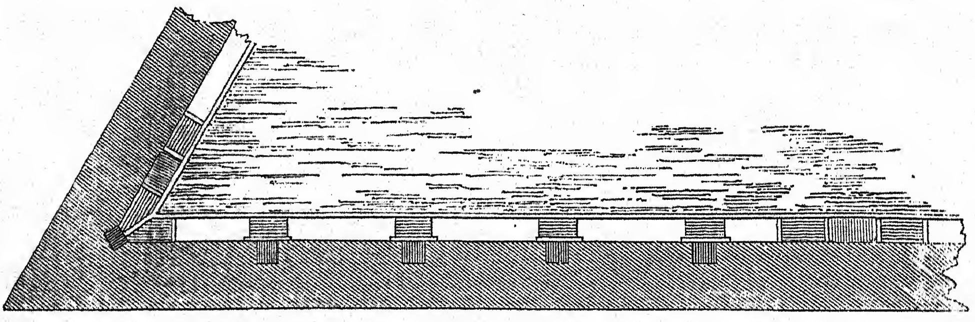
Fig. 2.—Face of a Bastion at Metz.



In this last example, where the revetment was 16 feet thick, the charges were not placed behind the wall, because, by the relative weight and comparative tenacity of the earth and masonry, the line of least resistance would have been in the direction of the terreplein of the ramparts; besides, experience has shewn that it is only necessary to place the charge at ⅔rds of the thickness of the wall from the face; that is to say, a little behind the centre of gravity, in order to throw down the entire mass. The economy of time and powder by this arrangement should never be lost sight of: the ⅔rds to be measured from the exterior face of the wall.

In some cases, where a gallery runs along the back of the wall, a chamber for the powder is made in the thickness of the wall, which is filled with one-half more than the usual charge, and the wall secured against the opposite side of the gallery, the intermediate spaces between the charges being left empty; the two extremities of the gallery only being tamped for a distance equal to at least one and a half times the line of least resistance.

Fig. 3.



At Milan, in order to render the demolition more complete by throwing down a greater quantity of earth than would be the case with the simple demolition of the revetment, the following plan was adopted: the wall at its base was 9 feet thick, counterforts 6 feet, 18 feet from centre to centre; the charges to destroy the wall were placed in the centre of the counterforts, and the other charges were placed in the earth behind the wall, at the distance from the charges in the counterforts of 18 feet for the line of least resistance; the charges in the counterforts were calculated according to the quality of the masonry, and the distant charges were 300 ℔s., that is, rather more than half of the entire charge, calculated at 12 ℔s. per double metre cube.* (See Table V.) The explosion caused a great quantity of earth to be thrown out: to have removed the same by shovel and barrow would have cost much more than the price of the powder.

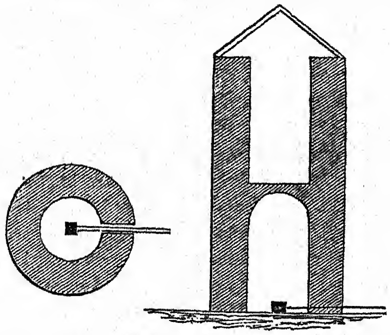
TOWERS.

In the demolition of towers, some examples will be given to shew what has been accomplished with success. A round tower at Ormea, 55 feet high, the walls 7 feet thick, and its interior diameter 12 feet; an arch 25 feet above the ground divided the tower into two parts; a box, containing 102 ℔s. of powder, was placed in the middle of the room on the ground-floor, which was filled with earth; the fuze was conducted

* About 10½ cubic yards English.

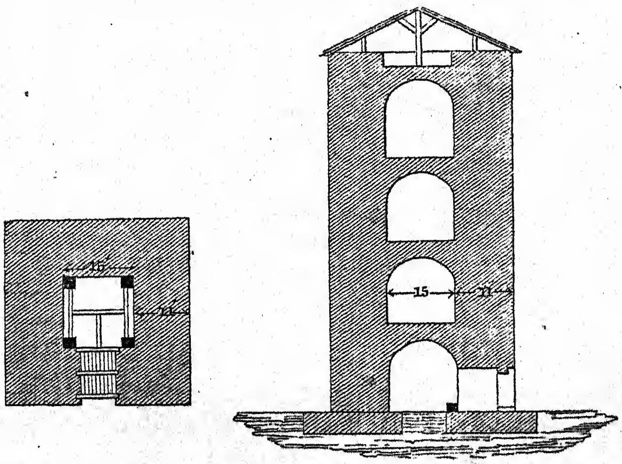
from the powder to the outside through a loophole. After the explosion, the yard of the castle was filled with the ruins, without any of the neighbouring buildings being in the slightest degree injured.

Fig. 4.—Round Tower at Ormea.



A square tower, 75 feet high, 15 feet interior side, and of which the walls were 11 feet thick, stood isolated in Fort St. Pierre at Verona: this tower was divided into four equal parts, or floors, by four arches; the upper one supported the roof. Four boxes, each containing 400 lbs. of powder, were placed at the four angles of the ground-floor, which was carefully filled with earth, wood, and stone; the fuze at the point of junction from the four charges was carried through the doorway, which was very firmly blocked up: the tower fell in large blocks, and no fragments were thrown beyond the small circle in which the ruins were contained, and which would scarcely have been large enough, had the tower fallen down of its own accord, without any explosive power having been employed.

Fig. 5.—Square Tower in Fort St. Pierre, Verona.



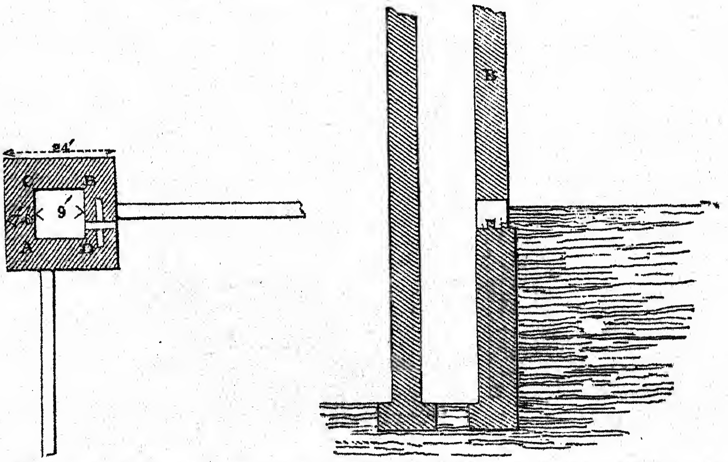
The masonry of this tower was of the best description: for 15 feet from the ground, the walls were of cut stone, and for this reason it was thought necessary to calculate the charges at the rate of 35 lbs. the double toise* cube, and to consider the charges

* About 77½ cubic yards English.

as isolated, notwithstanding the spheres of the explosion would cross each other: it was supposed that the tower would not have been thrown down if the formula for conjunct charges had been adopted: as none of the materials were thrown out, and as the tower fell in large blocks of 6, 9, and 12 feet of a side, it must be concluded that the charges were not too great: this proves that in fixing the quantity of powder, attention must be paid, not only to the quality of the masonry, but still more to the height of the walls when they are very thick, and exceed 30 or 40 feet. When towers are joined to the enceinte of a place, the adjoining masonry should be mined, as well as the tower; if not, there is a risk of only cracking the outside, while the inner part remains uninjured.

The following account of the destruction of a tower at Verona is interesting, as shewing a successful mode of procedure when there are buildings situated very near to the tower to be destroyed. The tower was 75 feet high on the side next the town, built on the side of a steep hill; its base was 40 or 50 feet above the roofs of the nearest houses, which were not more than 40 yards distant, the ground rising suddenly towards the fort; the face B, opposite to that facing the town, was only 40 feet high. From the fear of injuring the houses, it was determined to destroy part of the tower without throwing down the entire building: a gallery was made by a little door, which was in face B: if there had not been a doorway, the entrance to the gallery must have been made through the wall; a chamber was made in the diagonal of the angle D, and a second at two-thirds of the same face B D, which was, as well as the other faces, 24 feet of a side, outside measurement; the thickness of the walls was 7 feet 6 inches. It was considered sufficient to place 50 lbs. of powder in each of the two chambers; the fuzes were joined so as to cause simultaneous explosion: it was expected that by this arrangement the entire face B D, and part of face A D, would be completely destroyed, and also a part of B C, leaving the remaining portion standing: these expectations were more than realized, though no injury occurred to the houses.

Fig. 6.—Second Square Tower at Verona.



The towers in the works at Almarez, in 1812, were blown up by Lord Hill's corps, by placing 450 lbs. on the centre of the floor; and for the greater security of the miners, the powder was exploded by means of quick-match, and a train carried up to the first-floor, at which level the entrance gate was placed. The towers were

utterly demolished by the explosion: it is to be regretted that dimensions cannot be given.

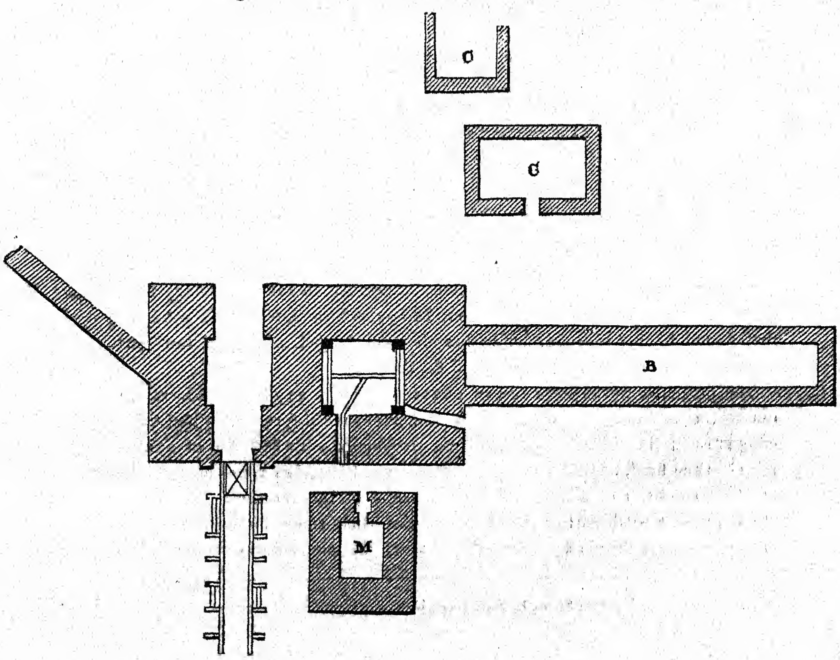
In some few instances, where no powder could be obtained, the ancient mode of mining was resorted to, and towers were thrown down by cutting away the earth under the foundations, and supporting the building on blocks of wood, the interstices between them being filled with combustible materials well ignited: when the blocks were consumed the building fell, for want of support. This method has been also practised for the demolition of revetments.

The following account of an explosion which took place at the Fort of St. Felix at Verona, to destroy simultaneously two adjoining towers, and other adjacent buildings, cannot fail to be interesting to an Engineer.

The extraordinary effects of this explosion would alone be sufficient to warrant the mention of it, even if it were not necessary to speak of the additional charges that are sometimes employed to increase the violence of the commotion, and to destroy at one blow groups of objects that want of time prevents from being destroyed separately.

One of these two towers was at least 85 feet in height; it was square; its interior side was 16 feet, and the walls 12 feet thick: at its left, as seen from the outside, there was another tower, which served as an entrance gate, not quite so high, but with walls as thick as the first. In front of these two towers, at about 39 feet, there was a sort of counterscarp, not revetted, in height 20 feet; and in the ditch formed by it, and exactly facing it at 6 feet from the great tower, was a square powder magazine (M), of which the interior side was 12 feet, and the walls 6 feet in thickness: to the left of the tower gate, and to the right of the great tower, were two walls, not backed with earth; to the last of which was joined a large building (B) that had served as a lodging for the Commandant of the Fort.

Fig. 7.—Tower, &c. at Fort St. Felix, Verona.



As the destruction of these masses bit by bit required more time than could be allowed, it was proposed to overthrow the whole by a single mine.

The great tower having one room the floor of which was on a level with the ditch and the powder magazine (M), it was resolved to place the charge there, divided in four boxes of equal size, placed at the four angles, and to make the total quantity five times the necessary charge to overthrow only the great tower. Its walls, as already stated, were 12 feet thick, and the quality of the masonry required 39 lbs. of powder for each double metre cube. (See Table V.) Thus each box, with reference to the tower alone, would have required 553 lbs.; but which, × 5, gives the intended charge for each corner, or 2765 lbs.; or the whole 4 × 2765 = 11060 lbs. Circumstances, however, caused it to be reduced to 8776 lbs., that is to say, to something less than four times the simple charge of 553 lbs. × 4 = 2212 lbs.

These four boxes having been placed at the four corners of the room, it was filled with earth, stones, and wood, the door and embrasure were strongly barricaded, and the whole was then fired.

The result of this explosion was that the two towers were *pulverized*, the powder magazine crushed, as if the charge had been placed within it; the wall of the enclosure to the left was thrown down to the extent of 130 feet; and that to the right, 52 feet in length, was entirely razed, and also the building (B): other buildings (C) that were bomb-proof, and distant from the centre of the great tower from 45 to 65 feet, were destroyed or shaken in such a manner as to render them perfectly useless. This explosion (which may lead to reflection and useful calculation on overcharged mines applied to demolition) was accompanied by no accident. One single fuze flew out by the doorway of the tower which was charged, and the explosion carried some rubbish to the distance of 160 feet.

The destruction of a place consists not only in overthrowing the fortifications, but also in destroying the interior military establishments, such as powder magazines, cisterns, arsenals, &c.: we shall therefore give an account of the manner of destroying them.

Fort Conception, on the road from Almeida to Ciudad Rodrigo, was successfully destroyed by gunpowder by Captain Burgoyne,* in the year 1810, after the capture of the latter place by the French army under Marshal Massena.

Fort Conception is of a square figure with two advanced works, one of a lozenge shape, and the other that of a trapezium: the bastions were full, the curtains casemated, and a small casemate in each flank. It was proposed to sink a shaft on the line of the capital, nearly to the level of the bottom of the ditch, and a gallery carried from the bottom of the shaft near to the escarp wall of each face, with a return for two chambers. This arrangement was necessarily altered, from the difficulty of carrying it into execution; it was therefore decided to take advantage of the casemates in the flanks, which were about 12 feet cube: the ravelins were also casemated, and 5760 lbs. of powder in barrels were lodged in each, a few portions of 1440 lbs., that is, one in each face and flank.

The detached works were full of casemates; a charge of 3840 lbs. was lodged in one of the angles of the gorge, and the other advanced fort, which had two circular casemates in the shoulders of the work, was loaded with 2800 lbs. of powder. The mines, when fired, exploded with full effect; good breaches were formed in the faces of the bastions, and small ones in the flanks of the ravelins: nothing remained standing but a small part of the salient angle: the lozenge-shaped outwork was as if cut in two parts diagonally; the half in which the powder was lodged was entirely

* Now Lieut.-General Sir J. F. Burgoyne, K.C.B., Inspector-General of Fortifications.

blown down, and of the other work the front face and great part of the flanks were totally destroyed.

MAGAZINES.

When time will permit, a powder magazine is destroyed by a series of mines, placed in the centre of the thickness of its piers and of its gable: these mines are then charged, according to their line of least resistance, and with regard to the quality of the masonry; they are then brought to act together, and the fall of the vertical walls necessarily involves that of the arch.

When there is no time to spare, the following process is employed, which requires no preliminary work.

The powder is placed in a heap, on the floor of the magazine; the doors and windows are fastened, and it is then fired by means of a hose which reaches from the powder to the outside of the building. As to the quantity of powder that should be placed in the heap, knowing the interior length and breadth of a magazine, and the thickness of its piers, a revetment imagined of the same thickness, and the same quality of masonry as the piers, and of equal length with the interior line of the piers and gables,—find out the number of isolated mines that it would be necessary to place behind this 'revetment' to throw it down, and what quantity of powder would form the united charges of all these mines: this quantity of powder, with the addition of half as much again, igniting in the interior of the magazine, will destroy it, without carrying the rubbish ten paces beyond it.

It is not necessary, when determining the strength of the charge, to take into consideration the height of the powder magazine, because the mines being generally as low down as they can be conveniently placed, the line of least resistance refers to the thickness of the wall rather than to the height; and the ruin of the upper part of a magazine is involved in that of the lower portion.

When the length of a magazine is greater than its breadth, it would be well to divide the powder that is placed on the floor in two or three equal heaps; and should the magazine in question have lateral passages, as is sometimes the case, a portion of the charge should be distributed in those passages: care should also be taken that these heaps may all ignite at the same instant.

BUILDINGS.

Having cited numerous examples shewing the mode by which magazines may be destroyed, and which may be classed under the head of *quiet** demolition, we shall give some extracts from the Journal of the memorable Siege of Saragossa in 1808, when the French General, in consequence of the little progress he had made by an open attack against the large convents and buildings, resolved to proceed by a covered attack, that is, by mining, which henceforward was the principal operation throughout the siege; the artillery being employed as an auxiliary. It is to be regretted that more details are not given, as to the thickness of the walls, and the rule by which the charges were calculated; the Engineer, however, will readily perceive of how great importance it was towards the reduction of the place that the explosions should merely produce a limited result,—that was, in general, to form a practicable breach in the face of the building, by which a column or body of troops could enter without losing the benefit afforded by the remaining walls to cover their approaches or communications.

"We took possession with great difficulty of the block of houses contiguous to

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* In contradistinction only to violent and hasty demolition. See article 'Petard.'

Santa Engracia. The Sappers worked across the first small street to the left of it, and were able to get into a room on the ground-floor of a house opposite to it: however, the enemy held most determinedly the cellars, the upper stories, and the other parts of the building; so that not being able to drive him out of it, it was blown up. The miners placed 200 ℔s. in the room which they occupied, and set fire to it: the house was thrown down, and by the consternation produced by the explosion we obtained possession of the whole block of houses.

"Towards Santa Engracia we blew up several houses; by the explosions a great number of Spaniards were buried in the ruins. Notwithstanding, the mines did not produce upon the minds of the enemy so great an effect as we expected; these enthusiasts, resolved to bury themselves in the ruins of their houses, did not permit themselves to be frightened by our firing of the mines; they did not abandon the buildings, torn and cracked by the explosions; and the briskness of their fire hindered us from establishing ourselves within them.

"Experience taught us that houses entirely thrown down by the mines were often an obstacle to our progress, since the ruins of them no longer afforded cover to proceed with the attack of the neighbouring houses; we could no longer cross these ruins without infinite trouble and danger. The Officers of Engineers calculated the charges of the mines in such a manner as to form a breach without throwing down the houses; the mines were particularly used for breaching the convents and the great buildings, which formed a series of citadels in the interior of the city.

"In general, when the Spaniards had been forced to abandon their houses, they set them on fire, so that the conflagration might become a barrier between them and us, whilst they could establish means of defence at a little further distance. The combustion of the houses at Saragossa, in the construction of which there is very little wood, is very slow and difficult, and does not communicate to the adjoining buildings: we were obliged to endeavour to extinguish these fires under a shower of hand-grenades, or to wait several days until the houses were entirely consumed, before being able to advance.

"We took several blocks of houses in front of St. Augustin, by opening the walls, either by blasting, by the mine, or by sap.

"When the enemy's miner appeared desirous of annoying the works, our miners hastened to load the chamber with 1500 ℔s. of powder each, and fired them; that against St. Francis formed a breach which was scarcely practicable. The two mines against the hospital produced every effect that could be desired, and we possessed ourselves of two-thirds of this building, which from the first-floor was an entire mass of ruins.

"At the centre attack, our miners had entered the cellars of the hospital to cross the Santa Engracia street by three galleries, but they were obliged to abandon them in consequence of the explosions of the hand-grenades extinguishing the workmen's lamps.

"In the cellars of the hospital a mine was loaded with 3000 ℔s. of powder; fire was communicated to it, after having drawn a great number of Spaniards within the sphere of action: the explosion was terrific, and threw down a part of the building.

"Two mines to make a breach in the University were loaded with 500 ℔s. each, but did not produce the desired effect.

"It was intended to open by a mine one of the houses near the Cosso, but too much powder having been used, the house was entirely destroyed, so that no cover could be obtained to reach the adjoining house.

"A tower without any outlet prevented us from penetrating to the left of the block of houses: a passage was opened by blasting, and to drive the Spaniards out of

the rooms which they occupied, shells were rolled into them: the explosion of one of these shells caused all the arches to fall down to the cellar.

"The miners made two chambers under the University, and loaded them with 1500 lbs. of powder each; the explosions formed two large breaches.

"A breach was made in Trinity church by blasting.

"At the centre attack, the miners fired a chamber charged with 1600 lbs. of powder placed under the great house with turrets; the half of the front was thrown down with a frightful crash, and buried fifty Spaniards under the ruins."

In 1824, after the great fire at Edinburgh, Lieutenant Head, Royal Engineers, (the present Sir Francis Bond Head, Bart.,) performed a very successful operation in bringing down some very high walls by the effects of gunpowder: he states that he bored five holes in a line parallel with the base of the building, and at a height convenient for the men to work; that the jumper was driven slanting into the wall, and penetrated one inch farther than the centre of the wall, which was three feet thick, in order that the powder should blow out both sides of it: in every instance the powder was imbedded in a stone, and not in mortar. In the five holes there were $4\frac{1}{2}$ lbs. of powder, but as only holes Nos. 1 and 2 exploded, the others having been smothered, the effect was produced by only $\frac{2}{5}$ths of that quantity. To insure the direction in which the walls were to fall, the ruins were first braced and bound together by chains, ropes, &c. A detailed account was published at the Establishment at Chatham in 1825.

CISTERNS.

What has been said respecting powder magazines applies equally to all bomb-proof arched buildings: a cistern thus arched can be destroyed either by mines or heaps of powder, although it may be filled with water at the moment that its destruction is intended. In the latter case, a raft is placed on the water in the middle of the area of the cistern, which is capable of supporting, without being submerged, a box containing the powder required for the proposed operation; and by means of troughs leading from the box, it is fixed so as not to be deranged by the combustion of the hose that they contain, and by which the fire is carried to the powder: a vast cistern was destroyed in this manner at Ehrenbreitstein.

Cisterns being generally sunk in the ground for a portion of their height, in operating as above described, the arch only may be destroyed; but to render the destruction more complete, when time will permit, charges are placed under the pier most accessible: the destruction of this pier brings down the arch, and consequently renders the cistern useless until rebuilt.

There is also another plan which may be adopted if time will permit for its execution; which is, to sink a shaft and drive a gallery under the bottom; which, being charged with sufficient powder to embrace the entire area within the circumference of the crater after the explosion, the destruction will be complete.

Without regard to the time which the Engineer can command, it may be observed that the first method, of placing the powder in a heap, is best when the cisterns are cut out of rocks; and the last two when the upright walls or piers rest against the earth.

Walls may be destroyed by boring holes in them at the four corners, just above the water standing in them; charging the whole with 10 or 12 lbs. of powder, and firing them simultaneously: if necessary, recourse may be had to a second operation of the same nature.

Another mode is to suspend a box, or barrel, containing 200 lbs. of powder, just above the water: the explosion will generally prove effective.

As it is very difficult to destroy a cistern cut out of rock, the next best thing to do is to fill it with materials and rubbish of any description that may be at hand.

Arsenals, hospitals, barracks,—in short, every military building,—may be destroyed when there is time; and it is necessary to economize powder by the following mode:

Remove all the wood-work, such as doors and windows; after which, cut away as much of the foundations as may be safe, leaving at each of the four angles of the building a column as broad as the wall is thick: if charges are lodged in these columns, the result cannot well be doubtful.

When there is not time to perform the above operation, place a quantity of powder in the cellar (or on the ground-floor, if there is no cellar). If it is difficult to determine the quantity of powder for the effect desired, place a charge in one of the rooms on the ground-floor at one end of the building; see the effect produced by the explosion, and then determine whether it will be necessary to increase or diminish the charge: in this mode of operating the ceilings should not be disturbed, and all the doors and windows on the ground-floor firmly shut and secured.

At Flushing, in 1809, a fine brick building in the dockyard, four stories high, with a strong cross wall in the centre in the direction of its length, was ordered to be destroyed: charges of 30 lbs. were placed in each of the four angles, as well as at the junction of the cross wall; the charges were not fired simultaneously; the effect was to bring down a considerable portion of each face of the building, but the charges at the junction of the cross wall were not sufficiently great to affect the superincumbent weight, as the charge blew away the loading which had been placed outside, but without injuring the wall; the loading in each case being the same.

BRIDGES.

The destruction of bridges as a military operation is generally required to be undertaken under peculiar circumstances; little time allowed for performing the work, and few hands or means to execute it. It frequently happens whilst an army is before an enemy, and closely pressed by him, that a bridge is required to be destroyed, to prevent his pursuing the retreating body, or to arrest his progress, in order to gain time for the movements of the army. In the retreat of the British army from Burgos, upwards of twenty bridges were destroyed, with the exception of two or three, which were only partially injured from want of time; the destruction of the others was perfect: in many cases the train was not lighted until the enemy were actually on the bridge; in others, as at Cabezon, the enemy's pickets were two or three days at one end of the bridge; an Officer of Engineers during that time waiting with a lighted slow-match, prepared to fire the train the instant the enemy should attempt to push on to the bridge; at the same time cautioned not to be deceived by false alarm of his advance. In many instances an Officer of Engineers was unexpectedly called upon for the duty of destroying a bridge, sent off at a moment's notice 40 or 50 miles, to be followed by a muleteer carrying two barrels of powder; without a miner, or tools, other than what could be collected in the neighbourhood of the bridge to be destroyed, and with such assistance in manual labour as could be procured on the spot, or by the assistance of some of the Dragoons forming his escort. The duty an Officer is thus called upon to perform is one of a most important nature; great interests are at stake; the manner in which it is executed may have great effect on the result; the fate of a campaign may depend upon it.

The following details will point out the mode pursued in the destruction of bridges during the Peninsular war under the Duke of Wellington. The bridges in general

were stone, with arches from 20 to 40 feet span, semicircular, of one stone (18 inches to 2 feet) in depth: the loading of the arches was generally solid masonry. The object desired was to destroy one arch, and in order to arrest an enemy for as long a period as possible, the largest arch, where there was deep water, was selected, unless want of time, or powder, made it advisable to choose another which appeared weaker than the others. The following modes were usually adopted:

1st. By sinking a shaft in the roadway, generally a few feet to the right or left of the centre of the width of the bridge, down to the haunch of the arch, with a very short gallery ending in a chamber, so as to lodge the powder in the middle of the width of the bridge under the roadway. If the charge was to remain for some time before being exploded, (it very often happens that a bridge is ordered to be prepared for destruction many days, sometimes months, if in a defensive position, previous to the order being given for firing it,) precautions were taken to secure the powder from damp, or wet,* either by putting it in a wooden box prepared for it, or any other which might be at hand at the moment: the train was then fixed to the box, and brought to the surface of the road up the shaft, which was then solidly and compactly filled in with the material which had been taken out, and if thought necessary, some of the stones of the parapet were laid over the mouth of the shaft to increase the resistance: to the end of the train was fixed a piece of portfire. If a corps or division of the army was to pass over after it was prepared for destruction, the train, or hose, was brought within a foot of the surface of the roadway, and then carried in a groove, cut on purpose, to the side of the parapet, the groove being filled in so that the road remained clear for the passage of troops or artillery without the chance of the hose being disturbed: precautions were taken to drain the roadway in case of rain, in order to preserve the train from getting injured by wet. Where a bridge is very wide it may be proper to divide the quantity of powder necessary for destruction into two charges, by sinking shafts at the proper points, according to the breadth of the bridge: this is likely to be attended with failure: it has happened that only one charge takes effect, leaving half the arch, which still affords a passage for troops. Several modes have been suggested for breaking down an arch, such as laying a quantity of powder upon the crown of the arch, so that the concussion may break it: this, if effectual, will require a very large charge, much greater for an arch of good masonry than 100 lbs., which the French state is sufficient; probably more than could be obtained or spared for this method.† Another is by suspending the charge under the arch: this is likely to be ineffectual from the difficulty of drawing up or firing the charge near the crown of the arch. In some cases a gallery has been driven into a pier at the level of the springing of the arch: there are difficulties attending this plan which make it unadvisable to adopt it. At Duenas,‡ in 1812, on the retreat from Burgos, the rear guard of the army was closely pressed by the enemy; the bridge was of solid masonry from the arch to the roadway; the miners had only time to strip off some of the pavement, and lodge two barrels of powder in the hole, covering them as hastily as possible with the small quantity of material at hand: when fired, the effect was to break down the entire breadth of the arch, making a gap of 15 feet. And in the Lines of Torres Vedras, a bridge was destroyed in a similar manner, by merely placing the powder on the crown of the arch, without any loading whatever.

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* When any of these mines fell temporarily into the hands of the enemy, they were invariably emptied for the sake of the powder.—*Ed.*

† Still perhaps worthy of further consideration and experiment.—*Ed.*

‡ The bridge in Plate XI. 'Field Sketching.'

At Port St. Maxance, in 1814, only one-half of the arch was broken down by the explosion, leaving the other, affording a free passage across it: the same result attended an explosion of the bridge at Ruivaes, in the north of Portugal, when attempted to be destroyed by the French during the Peninsular war. It is considered advisable, in placing the powder, to put it in an oblong form, rather than in a cubical mass, as by the latter mode it not unfrequently happens that a portion of the arch may be thrown down, as at Port St. Maxance. Where the bridge is narrow, there can be no necessity for sinking the shaft much deeper than half the width of the bridge, as want of resistance at the sides will render the additional vertical resistance of no importance.

A failure occurred during the Peninsular war, from having sunk a shaft down to a pier with the intention of destroying two arches: although great perpendicular resistance was gained, the effect was to blow out the sides of the pier, leaving the arches perfect.

In some old bridges, very large and substantial cut-waters will be found, which had been constructed subsequent to the erection of the bridge: these will probably offer great resistance, and contribute very much to produce the effects above described. In the destruction of two bridges on the Shannon, in 1845, the cut-waters being very substantial, and running very high up the face of the pier, were obliged to be taken into consideration when calculating the charges. (See fig. 14.)

In the Peninsular war, when there was time, the mines were loaded with every necessary precaution, the powder placed in a box, the hose laid in a wooden trough, and when required to remain any time under ground, the box and trough were well pitched, if there were means, and covered with straw, tarpaulin, &c., to preserve the powder dry: when pressed for time, the barrels were placed in the chamber, or the powder tied up in a piece of tarpaulin, or in linen bags: the hose was sometimes laid without a wooden trough, but with care that it would not be choked by the filling in of the mine. Saucisson or hose is easily made and carried. Bickford's patent fuze is an excellent material for firing mines;* the only objection is, the length of time it takes to communicate with the powder: in using it, great care should be observed to cut off a piece, and to examine if the end at the part cut off is well and properly filled with the composition. In blowing up the bridge at Athlone, in 1845, from want of attention to this circumstance, a good deal of delay and suspense occurred, and the person in charge was obliged to go and cut the end of the fuze, and light it a second time, before the explosion took place. It has been stated as objectionable to use two charges, where the effect desired could be obtained by one: but circumstances may arise which might make it advisable to do so, in order to gain time; for instance—in sinking the shaft in the centre of the roadway of the bridge across the Shannon at Carrick, the workmen came upon the spandril wall, which was of excellent masonry, and caused great trouble to sink the shaft through it, as well as consuming a great deal of time.

In destroying bridges by gunpowder in the field, the quantity was never determined by any fixed data for calculating the charge; and, moreover, had there been any rule established for so doing, it would never be wise, or prudent, in the Engineer employed to destroy a bridge, to run the risk of failure by being too precise; and to avoid the possibility of such, and to insure success, powder must be used freely: nevertheless, where there is no question of time, the Rules and Tables given in this article may be applied with advantage.

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* Especially for charges under water, taking care to use the appropriate description. See 'Fuze.'—*Ed.*

On the Shannon, where several old bridges had to be removed, consequent upon the improvements making in the navigation, it was considered an excellent opportunity of testing the accuracy of the data given by General Pasley, and more particularly as these bridges being situated in the centre of towns, with dwelling-houses on each bank of the river, abutting upon the ends of the bridge, large charges could not be used, without running the risk of injuring them: the result appeared to prove that the quantity of powder calculated in pounds of $L L R^3 \times \frac{1}{8}$, will be found just equal to the duty of blowing down the pier and the greater part of the two adjoining arches without dispersing the materials. This, in some cases, would be objectionable, as the mass of stone, &c. thus falling into the water-way of the arch, might, if the river was not very deep, greatly facilitate the passage of troops, and certainly aid very much in the operation of repairing the bridge. This would be an additional reason for using a much greater charge than the rule prescribes, in order that the materials may be dispersed; and if the explosion does not take place until an enemy is close upon the bridge, he will be liable to lose a great number of men by the falling stones. There is also another reason which may be urged for using large charges: the fracas, and noise of the explosion, and falling materials, will have a great effect upon soldiers, who, if accustomed to silent demolition, would not hesitate to rush on, and attempt to disturb the train, which might have been done on the bridges at Athlone and Carrick, where the demolition was silent but perfect, scarcely any report from the explosion, and unattended by danger to any person who might have been standing upon the bridge, just clear of the line of fracture of the arch.

For details of the demolition of the bridges at Banagher and Rooskey, see Appendix D.

BARRIER GATES.

The Petard (the ancient machine or instrument for blowing down gates, or barriers, at the entrance to a fortress, causeway, or building,) has for many years been in disuse in the British Service, having been found too unwieldy an instrument for attacks by surprise, or even at any time, under any circumstances: a bag of powder has been substituted, and it is believed on every occasion, where applied, with success.

Many experimental trials have been made at the Royal Engineer Field Establishment at Chatham, and also at Quebec. In vol. vi. of the Professional Papers of the Corps of Royal Engineers an account is given of two experiments made at Quebec in the year 1840.

The first experiment was against the outside of a pair of sallyport gates: the gates were 4 inches thick, 2-inch oak doubled, fastened inside by an iron strap 18 inches, $2\frac{1}{2}$ inches by $\frac{1}{2}$ inch, and further were secured by two bars of $1\frac{1}{2}$-inch round iron, fixed at one end by staples to posts in the rear; the other end was attached to the gates near the centre. The quantity of powder used was 50 lbs., sewn up in a leathern bag; it was suspended to one of the gates on the outside near the centre; the effect of the explosion was to destroy that half of the gate to which the bag was attached; the other was not so much injured: the gates were opened sufficient to allow four or five men to pass in abreast.

The second experiment was attended with much the same success as the first: but it appears evident, as very justly remarked by the Officer* who conducted the experiment, that a greater charge ought to have been used by 10 or 15 lbs., it being evident that had the gates been equal in strength to the entrance gates of fortresses,

* Capt. Simmons, R. E.

it is most probable that an assaulting column would have found it difficult to pass through the opening.

It appears from these experiments that the piers of the gates, although of green masonry, were uninjured by the explosion, and that the effect of the powder was chiefly at the point of suspension: hence, from the details given, it may be presumed that if the gates had been more strongly fastened, or if there had been iron stays at the top and bottom rails, a mere hole would have been blown through the gate, unless the charge had been doubled; in fact, the gates were only partially blown open, though the injury caused by the explosion was sufficiently great to enable a few men to pass through, which is the principal object to be attained: this is more easily, quickly, and better effected by a bag of powder than by any other means at present in use. The East India Company's Engineers have had opportunities of thus applying bags of powder. At Ghuznee, in 1839, a charge of 300 lbs. was used with success, divided and placed in twelve sand-bags, with a hose 72 feet long: it is supposed (although the account does not state it) that the bags were merely laid down on the ground at the foot of the gate, and there exploded.*

During the war in China, at the storming of Chin-keang-foo, 160 lbs. of powder, in bags, placed on the ground, blew a large two-leaved gate off its hinges, and flung it, almost uninjured, several feet back into the archway, though this last had been in a great measure filled up with bags of grain, &c., to obstruct the entrance.

LOCKS AND GATES.

In the principal maritime fortresses there are generally large basins in which men-of-war remain afloat, the water in them being retained by large gates, with a chamber for the ingress or egress of the vessels. A description of the operation † of destroying the chamber between the lock-gates at Flushing is herewith given: the result was everything that could be desired; the work was completely destroyed, and the explosion effected its object quietly, and without the slightest injury to the adjacent houses.

"The length of each pier was 128 feet, the thickness varied from about 27 to nearly 33 feet, and the height, above the floor of the entrance chamber, was 26 feet; the whole of solid brick-work, except a small arched channel or culvert, which ran longitudinally through the upper part of each pier.

"The object being to render these piers unserviceable, with the least possible injury to the town of Flushing, it was proposed so to place the charges that the foot of each wall should be blown into the entrance or lock chamber, and that the upper part of the wall, instead of being thrown upwards by the immediate effect after explosion, should fall as its consequence, or be so rent as to be incapable of partial repair.

"The position fixed upon for the charges was two feet above the floor of the lock chamber, and with a line of least resistance towards the face of each pier of 9 feet.

"The explosion was to take place at low tide, when there would be 7 feet depth of water in the entrance chamber.

"Four mines were determined for each pier, to be equally distributed and fired together; the charge of each to be three barrels of gunpowder, or about 270 lbs.

"A shaft, 7 feet square, was sunk for each mine in the ground immediately at the

* When the quantity of powder admits of its being hung to the centre of the gates, as was the case in the Quebec experiments, the party should be provided with a large gimlet or two, as the readiest and quietest way of suspending the powder-bags.—*Ed.*

† Abridged from Major-General Fanshawe's Report.—Professional Papers, vol. ii.

back of the piers, and upon reaching the required depth in each, a gallery 4 feet 6 inches high, and 2 feet 6 inches wide, was driven through the brick-work to the position for the charge.

"The general average of work accomplished by the miners was about 1¾ inch length of gallery per hour.

"Having reached the length intended for each gallery, a return was made for the chamber, of which the following is a section:

"The boxes to contain the charges were in the clear 19¼ × 19¼ × 22¼ inches, made of 1½-inch deal, the bottom covered with tarpaulin, and the cover made to fit exactly with ledges.

"The auget was fixed to, or rather housed into, the centre of the side of the box towards the gallery.

"A slight bridge was thrown across the entrance chamber, from pier to pier; the mines were connected together by the hose, and fired by a portfire equidistant from the centre of each charge, allowing 4 inches for every right-angled turn.

"The mines were exploded at low water, and the flood-gates were opened: the effect of each charge (excepting two on the eastern side, where the powder had become damp, and the explosion consequently only rent the pier,) was to blow out the bottom of the wall, and to destroy the adjoining part of the floor, which was of oak: the bottom of the piers being thus removed, the upper part almost immediately fell.

"So completely was the desire that the town should not suffer fulfilled, that not even a square of glass was broken in the lock-house, situated about 30 feet in rear of the western pier, whilst the effectual destruction of the piers themselves was accomplished."

References upon any of the above subjects may be made to the Professional Papers of the Royal Engineers; Sir John Burgoyne's Paper on the Destruction of Bridges, pp. 196, 197; Sir John Jones's 'Sieges;' Landmann, Pasley, Gompertz and Lebrun, Mouzé, Rogniat, &c., &c.

BOOMS.

In giving the following decisive experiment as to the facility of destroying booms *when unopposed,* it is right to refer to the third paragraph of the article 'Boom,' in which it is expressly stated that they must never be left unobserved or unprotected.

"Another interesting experiment took place yesterday off the *Excellent*, Captain Chads, on the most speedy and efficacious mode of destroying a boom which might impede the progress of boat squadrons in narrow rivers, as in the case of the recent attack on the pirates of Borneo by the squadron under Rear-Admiral Sir Thomas Cochrane.

"The first experiment took place on Friday last, but was on a smaller scale than the present, consequently not so convincing or successful in its results.

"On the present occasion two line-of-battle ships' lower masts* were taken from the old mast-pond, and moored at a short distance from the *Excellent*. Six turns of small chain lashing secured the two spars in the centre: the ends of the spars were secured by two half-hitches of chain, and two parts of the chain cable ran along the spars, and were secured in the same manner round the opposite extreme. The spars being thus secured, as if at the entrance of a river or creek, to prevent intrusion, the operations now commenced to dislodge them:—A breaker, containing 56 lbs. of gun-

* Diameter 27 inches, length 90 feet.

powder, was brought to the spot; at one end was 8 inches of portfire passed into it, over which was secured a copper tube made perfectly water-tight; and two threads of quick-match being attached to the upper end of the portfire, and the opposite extreme brought through to the mouth of the tube above the water, they were ignited, and the breaker being thereupon hauled and secured immediately under the spars, a sufficiency of time (eight minutes) was provided for the boat to get clear of the mass before the portfire reached the powder, which it did in the time above mentioned, when a tremendous explosion took place. On examining the spars and their fastenings, afterwards, the following was the result: 14 feet out of the centre of both spars was shivered into atoms, with one of the chain lashings blown up with the timbers. The same experiment was afterwards repeated upon the shorter end of the obstruction, under the parts of the chain cable, the result of which was that the whole of the spars were blown to pieces. These experiments were highly successful and satisfactory.

"This morning a further experiment was made upon the two long ends of the same spars, with the chain cable wound round them, and a hemp (13-inch) cable hove 'taut' in the intervals, the rest of the arrangements being the same as yesterday, except the quantity of powder, 112 lbs. being used to-day. The result was the total demolition of both spars, the chain cable was thrown to the bottom, and the hempen one blown away. Thus the success of the experiments is most unqualified and important. They were performed at the desire of Lord Ellenborough, who had expressed to Captain Chads, in a letter, his opinion upon the importance of Naval Officers becoming acquainted with the safest and most speedy method of removing such obstructions as those offered to the China squadron on the late occasion of the conflict with the pirates in the Malvodo river."—*From the 'Times' of* 15*th January*, 1846.

APPENDIX A.*

Demolition of the Left Face and Flank of the Glacière Bastion, in 1828, *by the* 5*th Company of Royal Sappers and Miners.*

The galleries† (A, B, C,) were executed by day-work, and advanced at an average 8 feet per day in a made ground of clayey soil, mixed with fragments of rock, of considerable compactness.

On completion of these galleries, the company was told off into 3 brigades of 1 serjeant, 3 corporals, and 9 privates, to relieve each other every six hours; the remainder employed in making hoses, casing tubes, &c. The work of forming branches and chambers 370 feet (total length) was equally divided among the three squads. As soon as the coffers were properly fixed and filled, and the train laid, each squad commenced a fresh branch, and the excavation was employed in tamping the one just completed.

The whole operation took a week.

A charge of 70 lbs. (13 inches cube) was let for its own depth into the counterforts at their junction with the escarp, with $LLR = 9$ feet nearly; and a charge of 50 lbs. (12 inches cube) let into the back of the escarp, also for its own depth (equidistant from the counterfort charges), with $LLR = 8$ feet. Average height of scarp, 21 to 25 feet: sound rubble masonry.

* Abridged from Captain Melhuish's Report, Professional Papers, vol. ii.

† Presumed from the scale of the drawing to be about $5' \times 3'$ in section.

Fig. 8.—Plan of the Mines in the Glacière Bastion, as destroyed by Colonel Durnford, R. E.

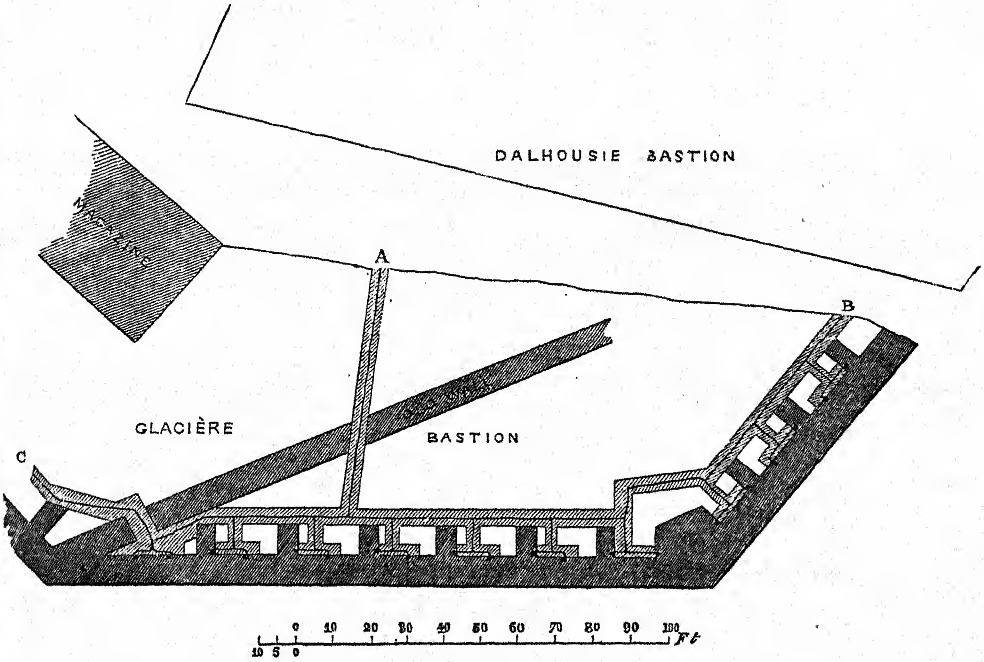
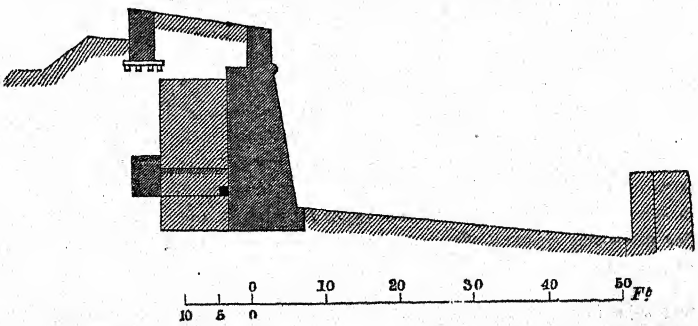


Fig. 9.—General Transverse Section of Fig. 8.



Accidentally, the whole twenty mines were exploded from A. The effect was perfectly satisfactory: the escarp crumbled to pieces, without a stone going 50 feet from its original position; and the whole parapet was brought down so as to form a thoroughly practicable breach.

The general line of explosion (A B C) was 220 feet long; the time of ignition along it did not exceed three seconds: hence it is to be presumed that a simultaneous explosion of mines, (requiring a great length of hose, much time to adjust, and

additional labour,) if resorted to, would not materially increase the effect.* The distance to which a gallery may be driven, without the aid of bellows, depends entirely on the state and temperature of the atmosphere. In the present instance, gallery A was driven at least 140 feet, and the lights burned tolerably well, though eight men were frequently employed in it. The above took place in the middle of February.

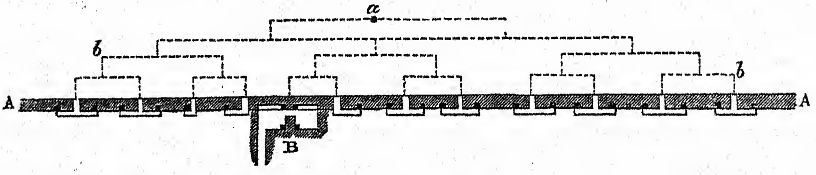
APPENDIX B.†

The galleries were driven through the escarp (A A), from face to back, with returns of 8 feet right and left,—chambers let fully into the back of the escarp.

	ft.	in.
Thickness of escarp at top	3	6
„ „ at base . . .	6	0
Height of escarp	20	0
Galleries from centre to centre . .	28	0
Chambers	14	0

The galleries through the escarp were 4 feet high × 3 feet wide; the returns 3 feet high × $2\frac{1}{2}$ feet wide; all in solid rock, or remarkably tough masonry. In some of the galleries there were only 18 inches of masonry, and then rock to cut through. In others the earth was very loose; and in the rest, clay and thin layers of rock mixed.

Fig. 10.—Plan of the Mines at Fort Schulemburg.
a. Focus of ignition. *b.* Train.



In the two small casemates (B), L L R = 14 feet, and each of the two charges there = 375 lbs.

In the escarp mines, L L R = 5 feet, the charge was 205 lbs.

Galleries commenced 2nd May. Loading and tamping, 29th May. Exploded, 10th June. One miner and two labourers per gallery; ditto per return.

The effect was most complete; the whole escarp with the 12 feet parapet being thrown down en glacis, particularly in front of the casemates.

In a subsequent communication to the Editors, Lieut.-Colonel Marshall observes, that the charges were decidedly too large, though the masonry was of the very best. The powder was of that left by the French in 1814; it was never used by our Artillery, but sold to the Greeks, or used in civil works: hence it would appear that the quality was deemed indifferent, and hence also, the apparent misproportion of the charges in the escarp chambers.

* The objection lies in the increased liability to accident to which long trains are subject.—*Ed.*

† Abridged from the Report of Lieut.-Colonel Marshall, R. E., Professional Papers, vol. ii.

For these escarp chambers $\dfrac{\overset{\text{lbs.}}{205}}{5^3=125} = 1{\cdot}64\ L\,L\,R^3$.

For the casemates considered as one mine $\dfrac{\overset{\text{lbs.}}{2 \times 375}}{14^3=2744} = \dfrac{750}{2744} = {\cdot}273\ L\,L\,R^3$, which is about $\frac{1}{6}$th of the above; but the position of these last was too irregular to admit of nice computation.

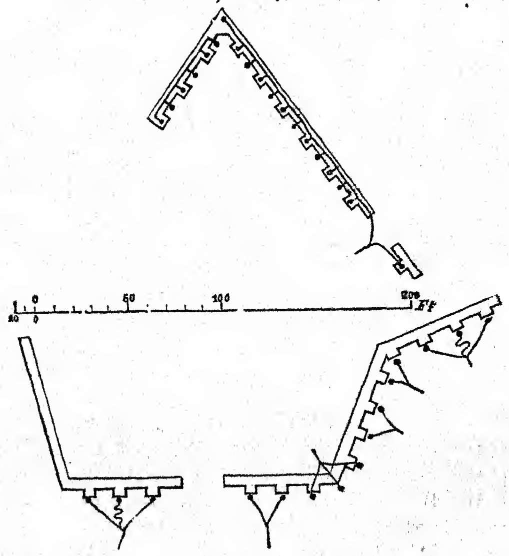
APPENDIX C.*

Report on the Demolition of the Revetments of some of the Old Works at Sheerness, on Saturday, July 14th, 1827.

GENERAL DESCRIPTION.

The revetments to be destroyed consisted of 266 feet in the face, flank, and curtain of a front of fortification in the old defences towards the land side, and of 260 feet of the revetment of the ravelin in front. The revetment in the Body of the Place was 16 feet 6 inches high, 3 feet thick at top, and 5 feet at bottom, supported by counterforts 3 feet wide and 4 feet long, placed at unequal central distances of from 15 to 17 feet. The revetment of the ravelin was 10 feet high, 3 feet thick at top, and 4 feet 3 inches at bottom, supported by counterforts 3 feet wide by 2 feet 4 inches long, placed at regular central distances of 20 feet. Those works were originally surrounded by water, and at the time they were ordered to be destroyed were found to be covered up 6 feet from the foundation. The masonry was for the most part good, the bricks frequently breaking before the mortar; but from the settlement of the foundation several of the counterforts were cracked.

Fig. 11.—Plan of Revetments destroyed at Sheerness by Colonel (now Lieut.-General Sir Charles) Pasley, R. E., July 14, 1827.



* Demolition of Revetments at Sheerness, by Lieut.-General Sir Chas. Pasley, from the Professional Papers, vol. iii.

Fig. 12.—General Section through the Body of the Place, fig. 11.

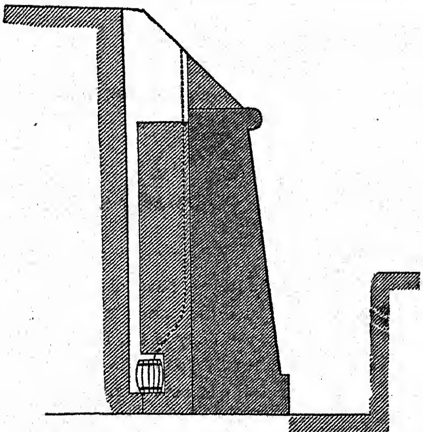
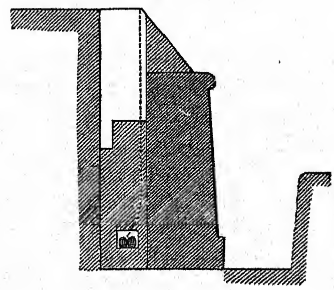


Fig. 13.—General Section through the Ravelin, fig. 11.



Scale to figs. 5 and 6.

PROJECT OF DEMOLITION.

A trench was ordered to be cut along the face of the revetment of both works, 6 feet wide, and as deep as the foundations. In the Body of the Place, shafts were ordered to be sunk at the back of the revetment, by the side of each counterfort, and returns to be made into them 1 foot above the foundation, and at such a distance from the back of the revetment that the centre of the barrel which contained the charge should be in the centre of the counterfort, and 7 feet 6 inches from the face of the revetment.

In the ravelin, shafts were also ordered to be sunk at the back of the revetment, by the side of each counterfort, as well as one midway between each; returns were ordered to be made into the counterforts so as to lodge the charge in the centre, and 5 feet from the face of the revetment; the other charges were also laid 5 feet from the front.

The charges were calculated exactly according to Lieut.-Gen. Sir C. Pasley's rules. In the Body of the Place, the lines of least resistance were taken 7 feet 6 inches; the calculated charge for which, for two-lined intervals ($\frac{1}{5}$th of its cube), is 84 lbs., but as some of the counterforts were more than 15 feet from centre to centre, a barrel or 90 lbs. was used. In the ravelin, the mines were exactly 10 feet asunder; the line of least resistance was 5 feet, the charge for which was exactly 25 lbs., being also $\frac{1}{5}$th of its cube.

In the large mines, the barrel was lowered down and placed on its end in the return, the copper hoops having been previously taken off, and a hole drilled in the top to receive the hose: the top was off at this period. That part of one of the staves nearest the hole, which projects above the top, was knocked off to prevent the hose from being cut whilst laying it; the hose was pushed into the barrel about 9 inches.

In the smaller mines, large bags were used, and the hose sewn into them; and where there was any symptom of moisture, laid in straw.

Three-quarter-inch hose was used, but it was thought that half-inch would have been quite sufficient.

The mines in the ravelin were fired in succession, first along one face, and then the other. For this purpose the hose was laid straight along the top of the revetment, communicating in succession with the short pieces coming from the charges, and fired from one extremity. In the Body of the Place, the mines were fired by twos or threes, for simultaneous explosions.

EFFECT.

The most complete demolition was produced. The whole revetment, from one extremity to the other, was laid in ruins, and yet so nicely were the charges calculated, not a brick was thrown 50 yards, and people at that distance might have looked on in security.

It was observed that the mines in the Body of the Place produced a greater effect on the ground to the rear than might have been anticipated: the shock on the adjacent mines prepared for explosion was such as to lay the hose, which was previously covered with 3 or 4 inches of earth, quite bare.

In firing the mines, commencing at No. 1 in the left face of the ravelin, Nos. 1 and 2 failed. This was owing to the hose which was laid along the top of the revetment having been displaced by people getting over the work at this corner. Had the precaution of taking a half-hitch with the hose coming from the mine, around that which ran along the revetment, been regarded, this accident would not have occurred.

In firing the mines in the right face, commencing between Nos. 18 and 19, Nos. 19 and 6, at the two extremities, failed; the hose in this case burnt to the edge of the shaft, and there stopped. I attribute this to the hose being choked at the angle, and the powder settling down a little in the shaft, so as to cut off the communication.

In the Body of the Place we commenced with Nos. 1, 2, and 3, simultaneously; then 4 and 5; then 6, 7, and 8; then 9 and 10; then 11 and 12; and then 13, 14, and 15. All these succeeded, but the shock from Nos. 11 and 12 deranged the hose of No. 13 so much that Lieut.-Colonel Pasley ordered it to be cut: after Nos. 14 and 15 were fired, the hose of No. 13 was completely buried, but we succeeded in finding it by digging, and fired it also; but owing to the quantity of rubbish that had closed in around it from the right and left, its line of least resistance was changed, and became vertical: the crater produced was very large.

HENRY JAMES,*
2nd Lieut., Royal Engineers.

APPENDIX D.†

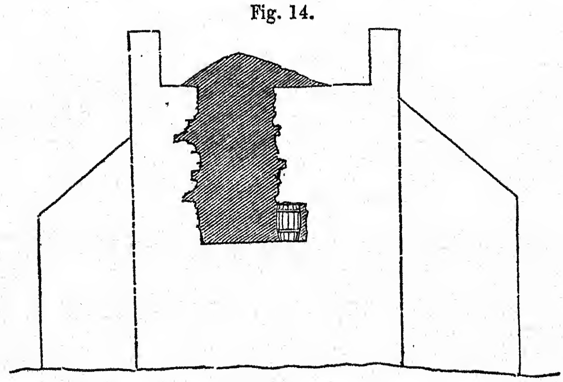
Banagher Bridge.

Of rubble masonry of a very inferior description, and consisting of seventeen semicircular arches.—Moderate but complete demolition was desirable. The piers varied from 14′ 6″ to 17′ in thickness: mean thickness 15′ 9″: hence L L R = 7′·87. Lieut.-General Pasley's rule of $\frac{\text{LLR}^3}{10}$ or $\frac{487,443}{10}$ = about 50 lbs., was tried, in *alternate* piers: the shafts were sunk 8 feet deep, a little on one side of the

* Now Capt. James.

† Abridged from Professional Papers, vol. viii. No. 1, by Colonel H. D. Jones, R. E.

Fig. 14.



mid-width of the bridge, so that the charge (lodged in one face of the shaft, and at the bottom) might be exactly in the centre of the pier and roadway: the tamping consisted of the excavated materials replaced. Bickford's fuze was used to ignite the charge;* and one man was told off to fire each shaft: the whole were lit at once by signal. "The explosions were nearly simultaneous; the entire bridge appeared to be raised a few feet, and then fell in a confused mass of stones, with the exception of a small portion of two piers, which remained standing: no stones were thrown to any distance, and the demolition might be considered perfect. The patent fuze answered admirably, as it has in all cases where it has been employed on the Shannon, and at other places where I have had opportunities of using it."

Rooskey Bridge.

Consisting of good external rubble facing, generally speaking filled (in both piers and spandrils) with loose earth and stones,—except where two parallel walls, about 18 inches thick, and 3 or 4 feet on each side of the centre, ran like partitions along the whole length of the bridge, crossing the spandrils, and passing down into the piers;—one large arch in the centre, and four smaller ones on each side. The six piers of the seven central arches were from 6 to 7 feet thick; the two piers nearest the abutments were 20 feet thick.

As it was necessary to avoid ruining the temporary wooden bridge running close alongside of it, very moderate charges were advisable; hence, experimentally, $\frac{LLR^3}{32}$ was tried at first in one of the 20-feet piers, and one of the small piers, but unsuccessfully. $\frac{LLR^3}{20}$ was then tried for both the large piers, and a much higher proportion $\frac{=LLR^3}{2{\cdot}75}$ for the small ones. The result was only partially successful in the latter; but by re-loading those that had suffered least with $\frac{LLR^3}{1{\cdot}318}$, the remainder were all brought down, excepting half an arch, which fell next day. This example is valuable, as giving a limit beyond which success cannot be expected. The bridge was an indifferent structure, and the charges the lowest possible.

The voltaic apparatus was used in this last instance, with, as usual, complete success as far as instantaneous ignition was concerned.

The powder used in the preceding cases was from private mills; strength $=\frac{19{\cdot}5}{21}$ of Government L. G.

* The Civil Engineer, apprehensive of failure, put two fuzes, but the precaution was unnecessary.

APPENDIX E.—Including Table VI.

General notices for Demolition, in reference to—
A. The position of the charge—
B. The mode of reaching the point where it is to lie—
C. The amount and size of the charge itself—
With regard to—
1. Revetments not exceeding Vauban's ordinary profile.
2. Revetments exceeding Vauban's ordinary profile, or in very massive pier-walls.
3. Towers.
4. Cisterns.
5. Military buildings.
6. Bridges.
7. Barrier gates and town gates.
8. Booms.

A.

A. With time. A 1. See fig. 1.
A 2. See fig. 2.
A 3. See fig. 6.
A 4, 5. In the heart of the walls, and particularly at the angles: or else, cut the lower part of the wall into piers, and deposit the charges in them.
A 6. In the piers; generally in two charges along the axis of the piers.
A 7. Powder-bags, hung up at the centre.
A 8. Powder-cases, merely pushed under.

A'. Against time. For all—adopt the most expeditious plan.
A' 1., A' 2. } In these, regulate the decision by hardness of escarp.
— hardness of backing.
— total work in gallery, or
— total work in shafts.
— quantity and quality of labour available.
— quantity and quality of stores.
A' 3, 4, 5, 7. Powder merely in bags, boxes, or barrels, in a heap within, with such tamping as the case admits of. Figs. 4, 5, 7.
A' 6. The powder sunk as deep on the crown of the arch as time permits, and loaded with what materials may be at hand.
A' 8. As before.

B.

B. With time. B 1, 2, 6. By shafts. Figs. 11, 12, 13; or
By galleries from the front, *e.g.* Figs. 1, 2, 10; or
By galleries along the rear. Figs. 3, 8.
B 3, 4, 5. The short gallery. Fig. 6.
Mem. B 1, 2, 6, generally become a question of economy in labour and stores; but should there be any deficiency in skill, or in such stores as mining frames, &c., the simplest plan is the shaft, if the material is firm enough to stand unsupported.

B'. Against time. B' 1, 2, 6. The shaft. Figs. 11, 12, 13.
B' 3, 4, 5. The short gallery. Fig. 6.

C. (See Table VI.)

C. With time. C 1, 2. (On two-lined intervals) $\frac{1}{2}$ LLR^3.
C 3, 4, 5, 6. $\frac{1}{10}$ to $\frac{1}{5}$ LLR^3.

C'. Against time. C' 1, 2. (On two-lined intervals) $\frac{2}{3}$ LLR^3 and upwards.
C' 3, 4, 5.—$\frac{1}{3}$ LLR^3 and upwards.
C' 6. 300 lbs.—1000 lbs.
C' 7. 75 lbs.—300 lbs.
C' 8. 56 lbs.—112 lbs.

TABLE VI.

Abstract of preceding instances of Demolition.

Place.	Nature of work.	Material mined in.	Location of Mines.	Average distance of charges apart in LLR.	Charge in lbs.	LLR feet.	Ratio of charge in lbs. to LLR3 in feet.	Remarks.
Turin A	Bastion escarp.	Best masonry.	Rear of escarp, and *in* counterforts.	1·5	97	7·0	·282	Demolition complete. Foreign powder.
Flushing B	Piers of lock-gates.	Brick.	*In* the pier.	3·55	270	9·0	·37	Do. British (Government) powder.
Quebec C	Bastion escarp.	Good rubble masonry.	Rear of escarp, and *in* counterforts.	1·3	{ 70 50	9·0 8·0	·096 ·097 }	Do. Do.
Corfu D E	Escarp. Casemate.	Rock and masonry. Masonry.	Rear of escarp. At end of the casemate each side of pier.	3 ×	205 750*	5·0 14·0	1·64 ·273 }	Do. Admitted to have been excessive. Foreign powder.
Sheerness F	Bastion Escarp. Ravelin escarp.	} Good brick-work. {	Rear of counterforts. Rear of escarp, and centre of counterforts.	2 2	84 25	7·5 5·0	·2 ·2 }	Do. Calculated on Lieut.-Gen. Sir Chas. Pasley's Rules. Government powder.
Banagher G	Bridge.	Very inferior rubble.	Piers.	×	50	7·87	·102	Do. Do. do. Merchant powder.
Shannon†H	Bridges generally.	Average masonry.	Piers.	"	"	LLR3	·33	Do. Merchant powder.
Verona I	Tower.	Brick or masonry.	Heart of the wall.	×	50	3·75	·95	Do. Foreign powder.

Deductions from the above as to Escarps,—i.e. from A *to* F.

Taking into account the use of foreign powder, and other circumstances, B, C, and F are the only cases that can be fairly compared. Of these, F, as established by Lieut.-General Sir Charles Pasley, affords the best basis; and taking the distances of the charges apart into account, it is very reasonably supported by B and C, and somewhat more approximately by A and E. B seems to be the most advisable in cases of doubt or expedition.

Considering what immense powers and unwieldy masses are generally opposed to each other in demolitions, and the rude results that, after all, are to be obtained, there is no ground for expecting a *very* close coincidence in these cases.

* The two charges of 375 lbs. were very close together.

† Excepting Rooskey, which was too peculiar for comparison.

DEMOLITION OF ARTILLERY.

COMPLETE DEMOLITION.

*Iron Guns.**—"The mode that I have generally adopted is to half-fill the gun with powder, and jam in one or two shot with stones, bits of iron, &c.; over this a complete tamping with stones and a little earth, till the bore is filled. I have seen this done with more than a hundred guns, and never knew it to fail.† To break off the trunnions is by no means an infallible mode of destroying ordnance: the French, in 1807, near Tarentum, had the guns of a battery thus imperfectly demolished in action,—in half an hour after, the work was recovered: they were probably fired on the ground. The place of the trunnion has also been temporarily supplied, in the British Navy, by passing a chain round the carriage (vertically) and slinging the gun in the bight, the breech of course resting on the quoins. The difficulty in laying a gun accurately when thus deprived of trunnions is very effectually met by laying a long triangular batten along the line of sight for the time being,—the vertex of the batten on the base ring, and the other end or base on the muzzle-mouldings,—this base being equal to the difference of the radii of the gun at those two points, so as to render the gun for the moment a cylindrical piece, and do away with dispart. The upper edge of this batten should have a groove along it, and be painted white. When time admits of only crippling guns partially by removing the trunnion, this is best done by laying its end on a block of wood, the blow being given by a sledge-hammer, or (if that be not at hand) by heavy shot; but the hammer is preferable as being more under control."

A shot may be fired at the gun behind the trunnions, which, if it should not break it, would render it unsafe. When old ordnance is sold, it is usual to break off one or both of the trunnions, to prevent their becoming an article of trade, except as old metal.‡

Brass Guns.—A shot is fired into them from some other piece, behind the trunnions, which will prevent the possibility of their being used again.‡

At Madrid, on finally evacuating it, the French destroyed their brass battering guns by keeping them over large fires till they 'drooped;' though, when well heated, a few smart blows from a sledge-hammer will render such guns useless.

TEMPORARY DISABLEMENT.

The spring-spike is used in rendering one's own guns for a very short time useless to the enemy,—as when guns are confidently expected to be quickly recaptured on the field. In this case, the gun would also, if possible, be dismounted; the rammer, &c., &c., would be taken away at all events.

The common spike would be used when the guns, on either side, are to be disabled as much as possible, though time does not admit of a more effective operation. This spike consists of a long tapering cone,—the larger end of steel, and the rest of soft iron, so as to bend back when driven well down on the lower surface of the bore.

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* For the first paragraph we are indebted to the verbal communications of Captain Sir Thomas Herbert, R. N.

† The doubt existed in consequence of a failure during the late war in destroying some French 36-prs. in a battery on the coast of Calabria. It has been suggested by an Artillery Officer, that partly burying the muzzle of an iron gun would be an assistance, if any doubt existed as to the efficacy of the processes now detailed.

‡ Paragraphs from Notices by Colonel Dundas, C. B., R.A.

Nails without heads (like flooring brads) are good substitutes for these; and it has been suggested by the author of the Introductory Paper to this work, that every Troop-farrier of Cavalry Regiments should be supplied with one or other of these last, and a hammer to disable the enemy's guns in the few minutes for which a charge, with only temporary success, may obtain possession of them. According to this Officer, this has been a singular point of improvidence in the British Service.

It would be desirable that the spike, punch, and hammer formed part of the equipment of the Pioneer. R. J. N.

DERRICK (Sheers, &c.)

The Derrick, Sheers, and Gyn have one object in common,—to find a point or fulcrum in space to which the pulley, in the shape of block and tackle, is to be applied; and this is effected by the above, on one, two, and three legs, respectively.

In the derrick and sheers stability is given by guys; in the gyn they are unnecessary. Wherever these guys are used, great attention must be paid to their being well fixed, or being (when requisite) duly eased off: when accidents do occur from neglect in this respect, they are generally *very* severe.

The applications of Derrick and Sheers about to be given are likely to provide for every probable occurrence, as the most extreme cases have been expressly selected; and these will be generally found in the practice of the Navy.

DERRICK.

An unusually bold application of this was made* with perfect success in building the block-house at the confluence of the Madawaska and St. John's, New Brunswick, in 1841. Figs. 1, 2, 3, 4, 5, Plate I., explain the operation, one peculiar advantage of which lay in the ease with which the whole apparatus was shifted from side to side of the building as required, and in the rapidity with which the work proceeded; for although the workmen (colonial) were so unpractised that they at first raised and placed only two logs (each 35 feet × 13 inches × 13 inches, weighing about 1¼ ton) per day, yet the walls of the second and third stories, each 11 feet high, were completely raised and framed by ten Canadian peasants in about a month; the last twelve pieces having been fixed in one day. Not a single accident occurred.

It is to be observed, that from the height of the building and its inconvenient position, and as the baulks (held on by the hand-guys *dd*) were not allowed to swing to the rear, no front guys were used. The baulks were landed at first on the two ends of the loose planks (*ff*), and afterwards turned over into their places by cant-hooks.

Plate I. Figs. 1, 2. B. Baulk just raised, slung to the tackle by common dog-chains.

a a. Double blocks.

b. Derrick.

c′ c c. Guys with a loop at the end, to be quickly thrown on, or taken off from, the head of *b*.

Mem.: *c′* is stronger than *c c*.

d d. Small hand-guys for guiding the block.

e. Leading block.

ff. Two 3″ planks to land the baulks; their own weight kept them steady.

g. Spars to prevent the timber from chafing.

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* This application was made by Captain Simmons, R. E.

Fig. 3. *a.* A round spruce-wood pole.

b b b. Iron hoops.

c. Of $1\frac{1}{2}''$ round iron, with linch-pin and washer; the wood being well guarded with iron at each mouth of the hole where *c* passes through.

Fig. 4. A baulk slung in dog-chains.

Fig. 5. A cant-hook: the lever (A) may be about 5 feet long.

GETTING IN THE BOWSPRIT BY THE FORE-YARD.*

(Here the derrick is made by lowering and slinging the fore-yard obliquely to the fore-mast.)

Plate II. "When a new bowsprit is to be stepped, it is generally (in the Merchant Service) got in without sheers, by the fore-yard (fig. 1); the slings being cast off.

"The fore-yard is lowered down one-third (or any other distance, according to its squareness), by the jears, if they be carried; or otherwise by tackles from the lower cap. The single block of the starboard-yard tackle is brought to the cat-head (*g*), hooked to a pair of slings, and the fall taken through a leading block (*h*). By bowsing on that tackle, and gathering in the larboard lift (*i*), the yard is got fore and aft within the rigging; and if the bowsprit be stepped between decks, it will require to be carried very forward, and the yard-arm may be lowered or topped by the lift as occasion requires. A strong lashing is passed round the mast at *k*, and a large single block at *l*. A hawser (*m*) is reeved through the top block (*n*), (or through a block lashed to the fore-mast head above the rigging) through the block (*l*), and the end is hitched round the fore-mast. The other end of the hawser is hove taut and belayed, which secures the yard against the strain of the purchase. The purchase-block (*o*) is lashed round the yard, and the lower block (*p*) is toggled to a stout selvagee on the bowsprit. A back rope or guy (*q*) is reeved through a block lashed round the fore-cap, and hitched round the bowsprit end, which guys it in the direction required, whether it be more horizontal or perpendicular."

In the Engineer Department, the probable application of the derrick, or the sheers, as given in Plate II., would be in setting up large flag-staffs, signal-posts, telegraphs, &c. It is however a powerful resource for the Service generally.

TO GET IN A NEW MAST BY THE OLD ONE, WITHOUT SHEERS.†

Fig. 2. "If a vessel have a damaged mast, and be so circumstanced that she cannot procure spars of sufficient dimensions to hoist in a new one by,—strip all the rigging, except the runner pendents (*n*), off the damaged mast. Take the runners and tackles to the chains, setting them taut, two fore and aft guys (*m*) to the mast-head, and also a girt-line block (*k*). Secure the mast above the partners with fore and aft tackles (*p*) and heel-ropes from side to side (*s*). Lash the purchase-block (*o*) to the mast-head. Whilst this is being done, let the deck be well shored below. When all is secured, saw the old mast off close to the deck, wedging it as it is sawn; and being cut through, move it aft by the guys and heel-ropes as before. Drive a large bolt into the head of the stump (*q*) remaining in the hold; and, the lower purchase-block (*r*) being lashed to it, hoist it out. The new mast is then got in by the purchase, as before; and when stepped, the upper purchase-block (*o*) may be shifted to the new mast-head, the lower

* From Darcy Lever's 'Young Sea Officer's Sheet Anchor,' p. 70.

† From Darcy Lever, p. 19.

one toggled to the selvagee on the old mast, and the runners, guys, &c., being cast off, the old mast may be hoisted out by the new one."

SHEERS.

Used for lifting and manœuvring a class of subjects too unwieldy for the derrick, and requiring greater control in management than it can afford. Amongst the severest practices are the lifting masts into ships in different ways: any probable Engineer operations of this description would be trifles compared to them.

Particular attention should be paid to the mode of moving sheers from place to place without taking them down, by means of the guys and heel-ropes.

GETTING IN LOWER MASTS AND BOWSPRIT.

1. *Setting up the Sheers.*

Plate II. fig. 3. "Sheers* for getting in the lower masts and bowsprit† are made of two large spars: a strong lashing secures them by their heads (*a*). Over the head of the sheers, at the lashing, a large three or fourfold block (*b*), according to the size of the largest mast to be got in, is secured, connecting itself by a fall to another block (*c*). At the head of the sheers are four ropes, called *guys*, two leading forwards, and two aft (*d*). Also at the upper end of one spar, a girt-line block (*e*) is made fast, and its line reeved through it: this is to hoist up a man in case of emergency. At each heel of the sheers there is a tail tackle (*f*) leading aft, and two others (*g*) are overhauled forwards.

"Previously to the sheers being raised, two planks (1, 2), long enough to lie over three beams, (which are shored below,) are placed upon deck on each side, for their heels to rest on.

Fig. 4. "The lashing of the sheers is passed like a throat-seizing, not too taut; and then the heels of the sheers are drawn asunder: they are laid over the taffarel (*h*, fig. 4); and (if the ship do not carry a poop) to make them rise easier, a spar (*i*) is laid athwart over the fife-rails. The lower purchase-block is then taken forwards, the fall (*k*) being overhauled, to the breast-hook, or the ring-bolt in the stem, for the main-stay. The fall being taken through a leading block, is brought to the capstan, and hove upon. The cross spar (*i*) cants the sheers, and their heels are prevented from flying forwards by the tail tackles.

"When the sheers are up, they are moved forwards or aft by the guys and heel-ropes.

"The guys are hauled taut, and the block cast off from the breast-hook."

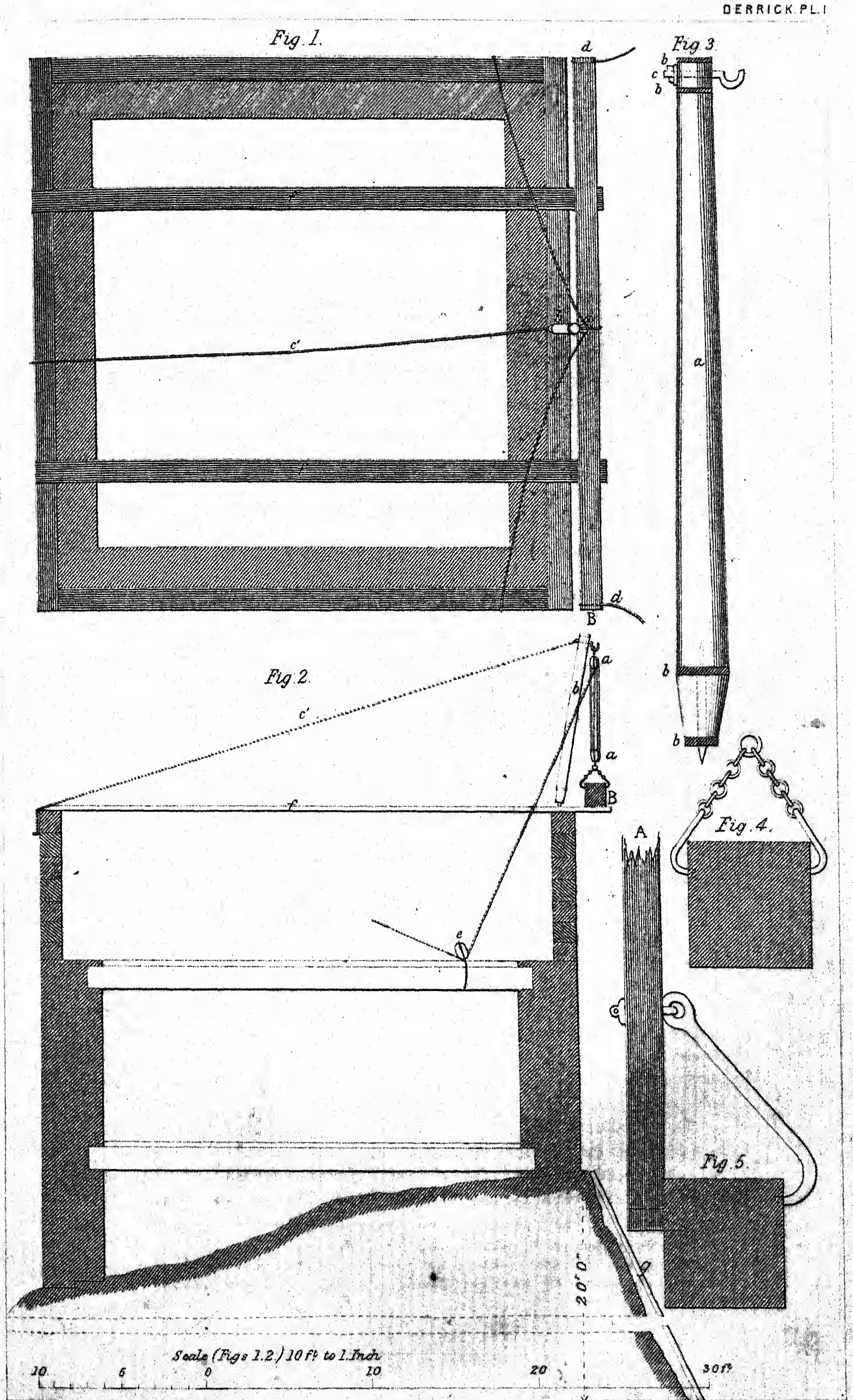
2. *Getting in the Mast, &c.*

Fig. 5. "The mizen-mast is first got in; for which purpose the sheers are placed before the partners or hole (*d*), which the mast is to enter; and the lower purchase-block is lashed on a little above the centre of gravity of the mast, that it may have a cant upwards. But in preference to this lashing, a stout selvagee, made of spun-yarn, should be taken round the mast (*a*), the bight put through the strap of the lower purchase-block, and a toggle clapped in. This, from its pliability, will be sure to hold, and is quickly done.

"Two girt-line blocks, one on each side of the mast-head (*b*), are lashed, to be ready to get the rigging overhead, and to hoist men on the trestle-trees, in order to place it properly. The end of the girt-line, which was made fast to one of the sheer-heads (*c*), is taken round the mast under the bibbs. This is called a *back-rope*.

* From Darcy Lever, pp. 17, 18.

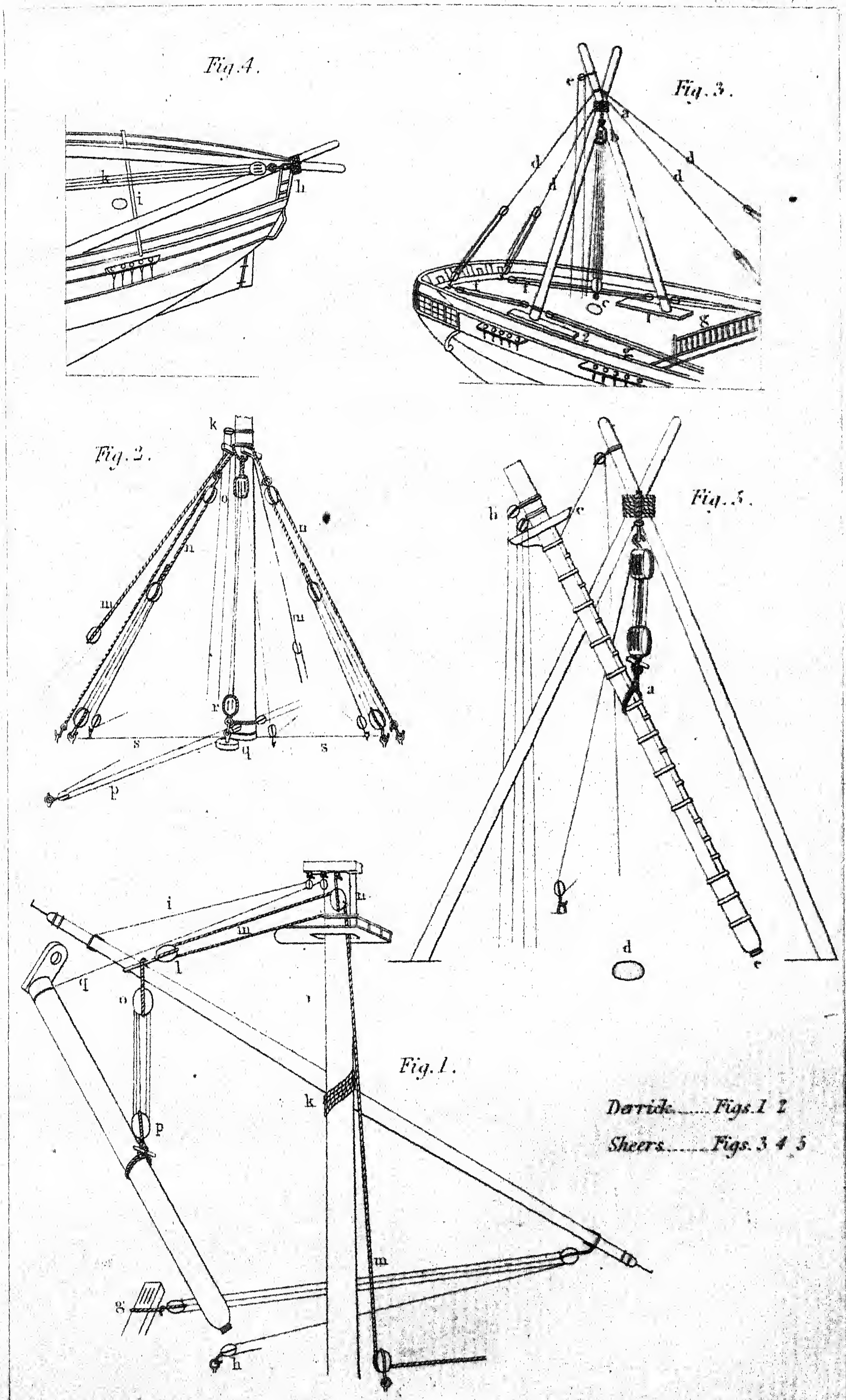
† In Dockyards this is done by either standing-sheers on the wharf, as at Woolwich, or by a sheer-hulk, as at Devonport. The above and following are resources on emergency abroad.



J. Simmons Lt R.E. del.

J.W. Lowry sculp

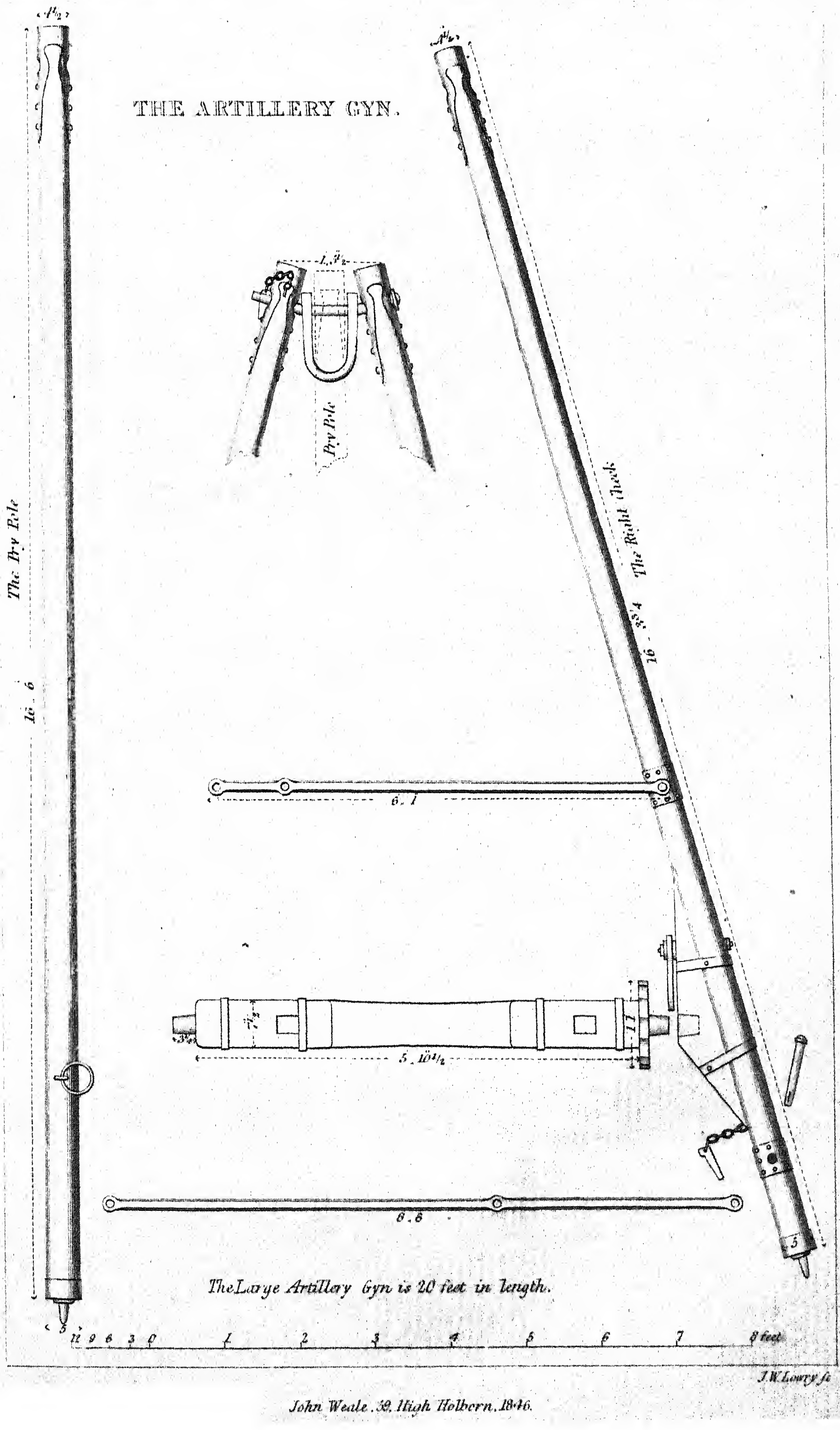
John Weale. 59 High Holborn. 1846



J.W. Lowry fc.

John Weale, 59, High Holborn, 1846.

THE ARTILLERY GYN.



The Large Artillery Gyn is 20 feet in length.

J. W. Lowry sc.

John Weale. 59, High Holborn. 1846.

"When the mast is high enough, this *back-rope* is hauled upon, which places it in a vertical direction over the partners or hole (*d*). Some hands on deck also assist at the heel of the mast, to make it enter. The purchase fall is then eased, and when fairly entered, they lower away; the people in the hold placing the tenon (*e*) in the heel, into a mortise of a large piece of oak timber, called a *step*, which is bolted on the upper part of the kelson.

"When the mizen-mast is fixed, the sheers are moved forward by the guys and heel-ropes, as seen in fig. 2, and placed before the partners of the main-mast. This and the *fore-mast* are got in, and stepped, in the same manner."

N.B. When *very* large sheers have to be set up from the ground, it will be best done by a pair of small sheers at the head in the first instance, so as to give them sufficient slope for the application of the power by which they are to be raised.

GYN.

Applicable when the weight to be raised is to have little or no lateral motion, as in the Artillery Gyn, Plate III. The 'cheeks' (or front legs) of this, together with the windlass, can also be used as sheers, especially in getting up ordnance on towers, &c., where the parapet is thick enough to allow the gun to rest well upon it when first brought in over the exterior crest, as in most cases the sheers must be set up afresh before they can be used for mounting the gun, or removing it to the interior of the work. The pry-pole is equally available as a derrick, particularly such as shewn in Plate I. Hence the singular value of this engine when well fitted and finished, as combining in itself the capabilities of derrick, sheers, and gyn.

In the Engineer Department this is seldom used, except in such very temporary arrangements for sawing timber as either do not admit of sinking a regular saw-pit, or where the logs lie so widely scattered that it is easier to bring the saw to them than them to the saw. The timber is hauled up between two rough gyns, one at each end, high enough to allow play for the 'pit-sawyer' standing on the ground: it is steadied by lashings, or by resting on cross-bars, which are removed as required, to allow the saw to pass. These gyns need only be of light spars to suffice for very heavy baulk, and require no iron fitments, it being enough to lash the three pole-heads together.

R. J. N.

DIALLING.

In all Dials, the Gnomon represents the Axis of the Earth: hence its angle (L. fig. 2, Plate) with the horizon is the latitude of the place, and it lies in the plane of the meridian.

The hour-lines are the projections of the horary meridians, given by the intersections of their planes with that of the horizon, or dial.

There is a great variety of dials, according to whether they are horizontal, oblique, or vertical, and also depending on their aspect with reference to the sun; but the above principle is common to all; and the Horizontal is the only one that will be here noticed, as being the simple form of which all the rest are only more or less curiously elaborate projections, and also as being by far the most generally useful, at outposts and other remote places, where there are seldom clocks, and where it is otherwise often difficult to obtain even a tolerable approximate to correct time.*

* Should the necessary instruments not be at hand, the latitude in the northern hemisphere may be obtained with sufficient accuracy by the careful use of a Gunner's quadrant (or other like simple contrivance) from the elevation of the Pole star. In the southern hemisphere we have no such

Fig. I. The most convenient of the trigonometrical elements to receive the projections for the hour-lines is the 'cosine' of the hour; therefore divide the circumference of the circle into 24 equal parts, *a b*, *b c*, *c d*, &c. for hours; join *a a′*, *b b′*, *c c′*, to obtain the so-called 'cosines;' and in fig. 2 reduce A *a*, B *b*, C *c*, &c., as sines of the angle L (latitude). Apply these sines to the 'cosines' A *a*, B *b*, C *c* (in fig. 1), as A 1, B 2, C 3, &c.; then the radii from the centre F— F 1 I, F 2 II, F 3 III, &c., will be the required hour-lines. The like process must of course be followed for half and quarter hours.

T, fig. 1, is the thickness of the gnomon.

In southern latitudes, the P. M. hours will be on the left of the gnomon, those of A. M. on the right.

The angle L (fig. 2) of the gnomon would in fig. 1 be placed at F F′, which neither looks nor answers so well as when the gnomon has a more central position: to effect this the hour-circle is advanced, as shewn in fig. 3, though the divisions are only continuations of the original projection of the radii, as given on the dotted circle, (repeated for the sake of clearness,) as a copy of fig. 2.

A cylindrical pedestal and circular dial will be found more convenient for adjustment than those of a square or rectilineal form in plan; on these last, once built, the position of the dial-plate cannot be corrected without being set awry. The width of the gnomon, as given in figs. 2 and 3, is not in proportion; when made in copper or brass, it need not be thicker than F F′.

MEMORANDUM.

In reference to the second paragraph, if the eye is familiarized with the position of the hour-lines of the place as given on the sun-dial, the watch and pocket-compass, so long as the sun can be seen, may be substituted for each other when either may be wanting in a strange or an intricate country, in a forest, &c., as a guide to the general direction of one's route; premising that—

A. At 12 A. M. the Sun must be due South in the northern hemisphere, and North in the southern; at 6 A. M. and 6 P. M. he must be due East and West respectively, whether seen or not; and at 12 P. M., due North in the northern, and South in the southern hemisphere,—under which last circumstances, strictly speaking, he can only be seen within the frigid zones.

B. Also, that at either pole there will be no correction for the hour-lines, as given in fig. 2, as the axis is perpendicular to the horizon; and at the Equator, where the axis is horizontal, the hour-lines will be parallel to the also horizontal gnomon.

Time, from the Compass.

Ex. In latitude 60° N., as given in figs. 1, 2, 3.

The bearings (due) of	XII.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
	XII.	XI.	X.	IX.	VIII.	VII.	VI.	V.	IV.	III.
will be respectively	0°	13°	27°	41°	57°	73°	90°	107°	123°	139°

as nearly as may be apprehended by a common compass; the bearings for the upper line being due East,—for the lower line, due West. Hence, where there is no mag-

assistance, but the latitude of the place may be obtained from a *good* map. Under like circumstances as to instruments, the meridian can be laid down by two vertical rods, say 100 yards apart, lined on the Pole star; or by dressing one of them on the line given by the same star and some known object. In the southern hemisphere, the simplest mode is by bisecting the angles A *a* A, B *b* B, &c., given by equal shadows of an upright central wire (*a*, fig. 4) on the respective concentric circles A B C, &c., drawn on a white surface. In all these rude contrivances the operations should be repeated many times, and the average of the *best results only* should be adopted.

Fig. 1.

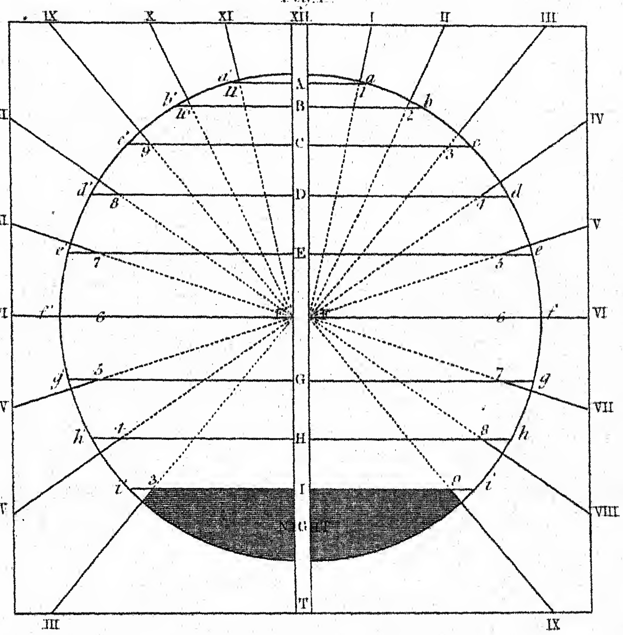


Fig. 2.

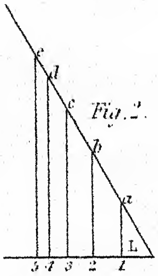


Fig. 5.

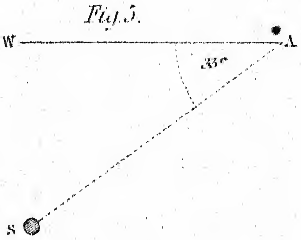


Fig. 3.

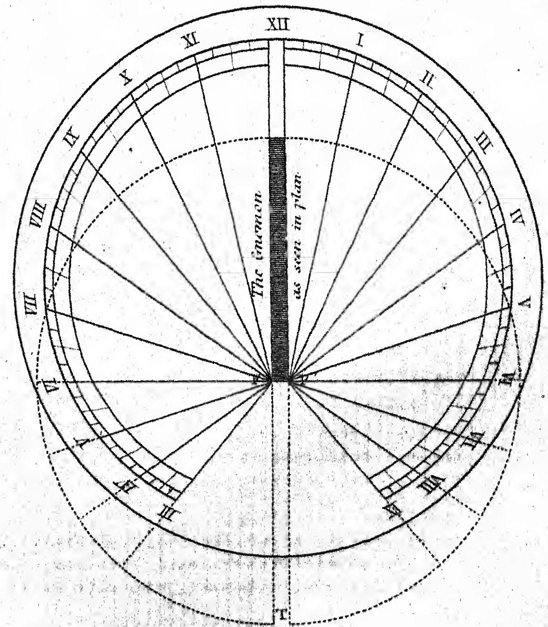
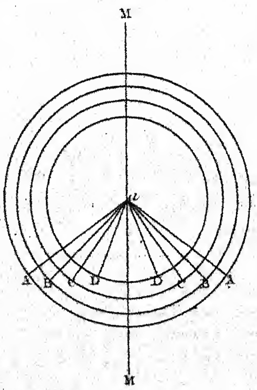


Fig. 4.



a. The head of an upright wire as seen in plan

M M *Meridian*

J. W. Lowry fc.

John Weale 59 High Holborn 1846

netic variation, these bearings of the Sun, by compass, would point out their respective hours. Suppose, however, that this variation is 10° E., the above will become—

XII.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
170°	3°	17°	31°	47°	63°	80°	97°	113°	129°
XII.	XI.	X.	IX.	VIII.	VII.	VI.	V.	IV.	III.
170°	23°	37°	51°	67°	83°	110°	117°	133°	149°

—and these, once determined by projection, (or else actually taken off by the compass from a sun-dial), and written (like the dial of a watch) inside the top of the compass case, will answer nearly enough for a considerable range round the spot for which they were computed, considering the rudeness of the operation.

Bearings, from the Watch.

Keeping paragraph A in mind, the problem is, given the hour and direction of the Sun, to find the nearest Cardinal Point.

Ex. Suppose at 4 P. M. the direction of the Sun is A S, fig. 5; required the direction of the West?

At 4 P. M. the *due* bearing of F. IV. (fig. 1) is 57°; hence, looking towards the Sun, its bearing (or that of F′ IV.) is 33° (= ∠ IV. F′ VI.) from the West; and if this be laid off on A S by the eye, or at most by the help of two sticks, as A S, A W, the latter will point due West. R. J. N.

DISEMBARKATION AND EMBARKATION—

Operations necessarily a combination of the *sea and land forces*, under the control and superintendence of the former; and hence *disembarkation* and *embarkation* are services forming what are termed conjunct expeditions, on a small scale for predatory purposes, or on a large scale of operations for conquest, or for transporting an army to the theatre of war in a foreign country.

In explaining the mode of executing the important duties of disembarkation and embarkation in detail, they are only noticed as combined operations of the two Services, land and sea. As regards naval operations alone, they will be omitted, having no reference to military subjects.

The article will be divided into the following Sections:

1. Disembarkation and Embarkation of Field Artillery.
2. " " Siege Artillery and Stores.
3. Embarkation of Horses.
4. Disembarkation of Infantry.
5. Naval Arrangements for ditto.
6. General Orders and Instructions of the Officers commanding the Army in Egypt in 1801.
7. General Remarks.

SECTION I.

ON DISEMBARKING AND EMBARKING BATTERIES OF FIELD ARTILLERY.*

1. The disembarkation and embarkation of field artillery may take place under circumstances so various, that separate instructions for each mode of proceeding would be endless. The following directions are formed upon general principles which will be found applicable to nearly all the cases which are likely to occur;—such as disem-

* Taken from the Instructions and Regulations for Field Battery Exercises of the Royal Artillery.

barking or embarking from a beach;—from a wharf;—with or without boats;—in presence of an enemy;—when all the carriages are to be in one ship, without horses; —when portions of horses and carriages are to be in the same ship, &c., &c. Of course all arrangements of every kind must be subject to the control and authority of the General commanding.

2. The embarkation of the guns and carriages in boats should form part of the exercise to be taught to each company; and one or two boats should be fitted for the purpose of embarking and disembarking in the face of the enemy. The horses, of course, would not be embarked; but the battery should march to the place of embarkation complete in all respects; and it is under this supposition that the following directions have been drawn up. Circumstances may render a departure from them necessary, but the general principles may always be adhered to, and the details will not be thought too minute, when the confined space of a ship is taken into consideration—how everything must be heaped and crowded together, and how liable small articles are to be mislaid, and not available when they are wanted, which is of the same consequence at the time as if they were lost to the service.

3. Field batteries should always be embarked by the Officers and men belonging to them, who will then know where each article is stowed; and much time will of course be saved in their disembarkation, which is always more or less attended with hurry and confusion.

4. When a new battery is issued from store, the harness should be properly fitted to the horses; and all the articles of equipment properly fixed to the carriages; after which, everything is to be re-packed in the vats and cases for their reception.

5. The embarkation on board all the ships should, as much as possible, be going on at the same time; but this must of course depend upon circumstances, and must be left to the discretion of the Commanding Officer. In some cases it may be practicable to embark the horses and the ammunition at the same moment; the latter down the after hatchway, and the horses down the main.

Embarking the Guns and Carriages.

6. Some previous notice should be given to the Commanding Officer, in order that he may make the necessary interior arrangements: he should be told the names, numbers, and tonnage of the transports allotted; whether horses and carriages are to be in the same ship; the number of horses each ship will contain; and whether the embarkation is to be from a wharf or beach.

7. If the battery is to be embarked immediately on its arrival, an Officer is to be sent forward to ascertain the precise spot for the embarkation; with the extent of wharf or beach which can be allowed for the battery, which should occupy as little ground as possible, if other troops or batteries are also to embark. Should the place not be the most eligible for the embarkation of the horses, which is the principal difficulty, he must endeavour to get it changed. He will ascertain the number of boats assigned, which should continue attached to the battery till the whole of it is embarked; and he will state the probable time of its arrival, that the boats may be in attendance. He will return and meet the battery, reporting the localities, facilities, &c., &c., for the embarkation. This is very essential, as any changes in the previous arrangements, which may become necessary in consequence of his report, may be more conveniently made before the battery arrives at the place of embarkation, where any unexpected alteration would add to the unavoidable hurry and confusion which generally attend such operations.

8. Two men are to be told off to each carriage, one of whom, for the gun, will be the non-commissioned officer in charge of the subdivision, and who is answerable for

the proper embarkation of it; he will prepare pieces of basil as follows, viz.: one for each driver, with his name and station, to tie on his harness; and one for each carriage, with its name and the names of the drivers attached to it, to nail on the head of the harness-vat. The jobbing smith is to be one of the men told off for the forge; the wheeler for the wheel carriage; and the non-commissioned officer or gunner in charge for the spare ammunition and store waggons; the collar-maker will superintend the harness. The men thus told off will amount to about thirty-two, which will be sufficient for the embarkation of the guns and carriages; the other men will be required for the horses.

9. On the arrival of the battery at the place of embarkation it is to be drawn up in line, in column of half-batteries, or of divisions, according to the space, but in as compact order and as close as is consistent with the due performance of the multifarious operations which are required. The horses are to be taken out, and drawn up in the same order as the battery; close to it if there be room; if not, in the most convenient spot near at hand. The harness is to be taken off and packed; and the horses will afterwards be led to the place of embarkation as they are called for.

10. A harness-vat should be provided for the harness of each carriage; and a large case for each gun and its waggon, and one for each two of the remaining carriages, as also one for the lighter articles of the store waggon. Into these cases many of the stores are to be put, such as intrenching tools, lanthorns, forage-cords, picket-rope, prolonge, &c., and any of the smaller articles. These vats and cases are absolutely necessary when it is known that the voyage is likely to occupy more than a few days, or when more than one battery is to be embarked in the same ship, or when the ship is likely to be crowded. In disembarking they must be carefully preserved, headed up, and sent on board the transport, or into store. When there are no cases, the stores must be secured to the carriages, or tied together as firmly as possible: the intrenching tools may remain with the carriages.

11. The harness for each carriage should be embarked with it, because in the event of a horse ship being lost, the horses may be replaced, but the harness cannot. Each set should be well secured together with a forage-cord or lashing-rope, and a piece of basil with the driver's name tied to it. The harness for each carriage should be packed under the superintendence of the collar-maker in a separate vat, which should be placed near the horses: one of the gunners will receive from the non-commissioned officers some tacks, and the piece of basil with the name of the carriage, which he will nail on the top of the vat: as soon as the harness is packed, the gunner will put on the head of the vat and nail on the chine-hoop inside the staves: after which the vat is to be rolled close to its own carriage. When there are no vats, it is still more essential that each set should be well secured together, as before stated; the sets belonging to each carriage will then be collected and placed close to it. The harness is the last thing to be embarked.

12. If there be room to draw the battery up in line, and all the carriages are to be embarked in the same ship, the waggons will cover their respective guns; the other carriages in two lines, viz., the spare ammunition waggons on the left of the guns, the wheel carriage covered by the store waggon, and the forge on the left of the whole. When the carriages are not all to be in the same ship, the additional carriages must be equally divided among the subdivisions.

13. If, from want of room, the battery is drawn up in column of divisions, and all the carriages are to be in the same ship, the spare ammunition carriages, wheel carriages, store waggon, and forge, are to be at the head of the column: when the carriages are to be in different ships, these carriages are to be equally distributed among the subdivisions.

14. If boats are to be employed, their number will of course depend upon their tonnage; and their loads must be regulated by the state of the weather and the distance of the vessels.

15. In embarking from a beach it may be necessary to erect small sheers, made of a couple of top-gallant masts, which should be previously prepared for that purpose.

16. If the embarkation takes place from a wharf, the battery must be drawn up in the most convenient place near at hand, and everything prepared as directed. If there are cranes, and the boats are much below the top of the wharf, the guns and ammunition boxes should be lowered into the boats by means of them; but when the gunwales are nearly level with the wharf, the ammunition boxes may be more expeditiously put on board by hand; and if there are no cranes, the guns may be parbuckled into the boats. Light 6-pounders are easily managed, but these directions apply more particularly to the 9 and 12-pounders.

17. The men told off to the carriages will prepare them for embarkation. They will take off the side-arms and secure them together, take out the elevating screw, unkey the cap-squares, scrape the wheels, unlash the ammunition boxes, and coil up the lashing-ropes. Each carriage when called for is to be run forward to the boat or crane; the gun is to be unlimbered and dismounted; the ammunition boxes, shafts, wheels, &c., &c., to be taken off; the washers and linch-pins must be carefully put away in the slow-match box, and in the small box between the limber boxes: if they are left in the axle-tree, they are liable to be lost.

18. An intelligent man from each subdivision must be stationed in the hold, that he may be acquainted with the situation of everything belonging to it. Every article must be stowed away with the greatest care, and arranged in the best manner possible, so as to be got at without delay: the marked side should invariably be in sight, which will often save much trouble and delay in disembarking.

19. Those articles which will be the last required when disembarking are to be the first to be embarked. When all the carriages are to be in one ship, the divisions and everything belonging to them should be kept together as much as possible. The first carriages to be embarked are the square ammunition waggons, store carriage, wheel carriage, and forge; these are to be stowed forward: the third division next to them, and before the main hatchway: the second division next to the third; and if any part of it comes under the hatchway, the first division must be put on the top of it, directly under the hatchway: if there be room, the second division may be stowed abaft the hatchway: the whole of the guns are to be together directly under it. Should two batteries be embarked in the same vessel, they should be stowed away on different sides of her.

20. The guns should generally be in the bottom of the hold; their vents turned downwards, and a fid in them to prevent their being choked. In some cases when the battery is a light one, two of the guns, light 6-pounders, may be lashed on the deck, if the voyage is not likely to last more than two or three days.

21. When the battery is embarked in different vessels, every part should be complete, and a proportion of general stores be on board of each, so that, in the event of the loss of a ship, the remaining part of the battery may not be disabled.

22. If the voyage is likely to last more than a day or two, the cartouches with the ammunition must be taken out of the boxes, and stowed in the magazine: one or two intelligent men in the hold must be told off to this duty. The ammunition must be so placed, that whatever part belongs to any particular carriage may be got at without difficulty. When the cartouches are not taken out, the boxes must be stowed well aft in the hold, or between decks, and they should be well covered with wadmill-tilts, hair-cloths, or the tents of the battery.

23. When the disembarkation is likely to be opposed, the transports should not be loaded or lumbered up with anything which will occasion delay in getting out the battery that may be required to accompany the troops in the immediate advance, or which may be necessary to cover the landing of the main body of an army.

24. When no opposition is expected, the vessel may be more filled, but the battery should be so placed as to be most readily got at.

Embarking the Horses.

25. The embarkation of the horses is of more importance than that of the guns, particularly if it be necessary to take them alongside the vessel in boats; in bad weather the guns and carriages are easily hoisted in, but the horses cannot be: if the embarkation of both therefore cannot go on at the same time, the horses should be embarked first.

26. The horses are to be embarked in the same order as the carriages, taking care that the officers' and non-commissioned officers' horses are on board with the subdivisions to which they belong. The farriers and shoeing-smiths should be distributed in different ships, and those which have none should be visited by them during the voyage.

27. The embarkation of the horses on board all the ships should as much as possible be going on at the same time. If in boats, the first that comes should have a proportion for one ship, the next boat for another ship, and so on; as by attempting to complete one ship before another is begun upon, it will often happen that the horses are kept waiting alongside, and the other ships are unemployed.

28. Horse ships are always provided with slings for hoisting in the horses; they are made of stout canvas, and are about 6½ or 7 feet long, and from 2¼ to 2½ feet wide: these should be minutely inspected by the farrier and shoeing-smiths, and if their appearance is in any degree suspicious they should not be used, but new ones prepared, which, when there are materials, should be made by men of the battery.

29. There are different ways of embarking horses, which arise from local circumstances, and each of them requires a different mode of proceeding.

30. *First.* When the transports can come alongside the wharf and take the horses on board at one operation. *Second.* When the transports cannot come alongside, and it is necessary previously to embark the horses in boats. *Third.* When the horses are embarked in boats from an open beach; or when the gunwales of the boats are nearly level with the wharf, either from its being high water, or from there being little rise or fall of the tide.

31. The embarkation of horses from a beach, or from a wharf, in boats, as also the hoisting them from a wharf when the vessel is alongside, is carried on by the artillerymen, assisted by the sailors. When the vessel is at a distance, the men who are in the boats with the horses must assist the sailors; and it is desirable that an Officer should be on board to superintend.

32. The first case (see No. 30) is the best, easiest, and most expeditious; resembling in all respects the hoisting a cask in and out of the hold. The following preparations in the ship are necessary: The main-yard is to be topped up as for hoisting in a boat. A tackle is to be rigged to that part of it, under which the horse will be brought for hoisting in; a leading-block is to be on board, through which the running end of the tackle is to be passed, which may be brought on shore, to give the men a longer run; or it may be kept on board. A similar tackle is to be rigged to the main-stay, directly over the middle of the hatchway, for lowering the horses into

the hold; there is also a leading-block to this tackle, but the running end of the tackle is to be kept on board, and the running block of it secured to the running block of the main-yard tackle.

33. When the ship cannot come so close to the wharf as to bring the horse directly under the tackle, one end of a strong guy must be secured to the lower block of the main-yard tackle, and a turn or two taken round a post; it must be eased off gradually as the horse rises, to prevent his swinging against the ship: when he is directly under the tackle, the guy must be let go.

34. There must be a double guy made fast to the horse's head, one end of which is to be on shore, the other on board, to keep his head steady, and in such a direction that it may not strike against anything: too much attention cannot be paid to have this rope under command, particularly in lowering the horse into, or hoisting him out of, the hold: for in the former case, as soon as his feet touch the ground, he is apt to spring up, and if his head be not directly under the hatchway, and every thing clear above him, he may strike his head and be ruined. A shoeing-smith should be in the hold of each ship to receive the horses, and if there are not enough for this, they should be sent from ship to ship.

35. Horses should generally be blindfolded, which prevents their being frightened and troublesome. A horse requires at least four men besides the driver to sling him, viz., one on each side, one at his breast, and one behind. One end of the sling is passed under his belly, and both ends made to meet over his back; one of the men passes his loop or handle through the other; it is received by the man on the other side, who hauls it through, hooking the tackle to it, both men holding up the ends of the sling. The men at the breast and breech bring their ropes round and make them fast to the grummets or thimbles. The driver holds the horse's head, and makes fast the guy to it.

36. The horse being ready, the word '*Hoist-away*' is given, and the men at the main-yard tackle whip him up, the slack of the stay-tackle being hauled in as the horse rises, his head not being let go till he is fairly off the ground, and deprived of the power of injuring himself. When the main-yard tackle is high enough, a turn is to be taken with the fall of the stay-tackle, round a belaying-pin, and the main-yard tackle eased off till the horse remains suspended by the stay-tackle alone, and hangs directly over the centre of the hatchway; the stay-tackle is then eased off till the horse is in the hold. The slings are then taken off, and he is led to his place and baled up; the first horses always being led forward, or aft, as the ship fills; the stalls nearest the hatchway being reserved for the horses which are first to be landed.

37. The second case (see No. 30) is more tedious; double time is required to hoist and lower the horses, as each operation must be twice performed; to this must be added the time occupied in the passage of the boats to and from the vessel.

38. Sand or straw must be put into the boats to preserve their bottoms, and to prevent the horses slipping. They should stand athwart, the head of one horse being on the starboard side, and the head of the next to him on the larboard side. The drivers are to sit on the gunwale, or stand between the horses.

See 'Derrick.'

39. Sheers or a derrick are absolutely necessary, because the tackle must be of such a description as to raise the horse off the ground instantaneously, which a crane cannot do. There are boxes into which the horses may be made to walk, and which may then be raised by a crane; but these boxes cannot be expected, or even used, when many horses are to be embarked. The head of the derrick must incline inwards while the horse is rising; but when he is high enough, the head of the derrick or sheers must be forced out, to bring the horse directly over the boat. Horses may in this way be embarked in boats from a beach.

40. Decked gun-boats or coasting vessels are very convenient, when there is time and materials to make the necessary preparations. In addition to the greater number of horses which they will hold, when compared with the transport-boats, an important consideration is that they can be used for horses in weather when the others cannot, but which, however, may be available for other purposes; a want of boats being always the subject of complaint in embarking and disembarking. As the decks of these vessels have sometimes a considerable slope, it will be necessary to lay a flooring of plank, and to make fast a spar on each side to prevent the horses slipping. A double line of horses may be embarked when the vessels are large, the one line standing on the larboard, the other on the starboard side. These boats may come alongside a wharf, and the horses can walk on board by the means of a small bridge or ramp of planks.

41. In the third case (see No. 30) the horse is to be led to the boat, and the halter given to one of the men in it, who will pull him forward, whilst the others push him behind and urge him with the whip, in order to make him leap at once into the boat; for if he only gets his fore feet in, they may slip; he may then overreach himself so as to be unable to get in, and he may be strained. A quiet horse should first be embarked, as the others will follow more readily when they see a horse or two in the boat. Care must be taken to trim the boat by turning the horses' heads successively to and from the shore as they are embarked. When the embarkation takes place from a beach, the gunwale of the boat should be inclined towards the shore, that the horses may the more readily jump in.

42. When a horse falls sick on board ship, and it becomes necessary to remove him nearer to the hatchway, the bales between him and the stall into which he is to be shifted are to be taken down; the heads of the horses in those stalls are to be turned from the sick horse, and he is to be led close to the manger past them: the horse which stood next to him is put into his stall, and the others are closed in. A stall or two should always be left vacant for sick horses.

43. The ground on which the horses stand should occasionally be levelled; by removing the bales, the horses can be put close together, and the vacant space may then be made smooth; this is practicable at any time, unless the weather is very bad.

Disembarking.

44. When there is no particular hurry, and no enemy to oppose the landing, the disembarkation is exactly the reverse of what has been detailed. The harness is the first thing sent on shore. If the water be smooth, with little surf, the disembarkation may easily be carried on upon the beach; the horses will leap out of the boats, and on any emergency, if the vessels are near, they may swim ashore; but this is not recommended, as the sudden transition from the heat of the hold to the cold of the water may be prejudicial, particularly as the horse cannot be well dried, as every person is fully employed in more essential duties.

45. In disembarking, great care must be taken of the vats and cases; they should be headed up and preserved. (See No. 10.)

Embarking when an Enemy is present, or close at hand.

46. It is natural that an Artillery Officer should wish to embark all that he can as soon as possible, in order to have less to put on board when the last of the troops are embarking, or less to lose; but the probability or possibility of leaving some guns should never be put in competition with the more important consideration of keeping on shore to the very last a force of artillery sufficient to repel any attack. The horses

and all the carriages should be previously embarked, except the guns and limbers, in such proportion as is calculated for the position to be occupied: if it be near the water, the limbers may also be sent off, and the guns dragged to the boats by men. A sufficient supply of ammunition should be at hand in a boat or two, close to the shore. If the position be a mile or two from the place of embarkation, it may be necessary to retain a proportion of horses.

47. The guns which are last embarked are generally put on board the launches of men-of-war, fitted for the purpose, as follows: two planks are laid from the bow to the stern, parallel to each other, at the distance of the span of the wheels; a bead is nailed to the inside edge, to prevent the wheels from slipping off. Two gang-boards, which can be laid out or taken on board, are fitted to the bow ends of the planks, so as to reach from them to the shore as a ramp; and a third one is sometimes fitted to receive the trail of the carriage; by means of these the guns can be run into the boat with the greatest ease. These boats are towed by smaller ones.

48. If the enemy be actually present, the embarkation of the last of the troops generally takes place at night.

Disembarking when opposed by an Enemy.

49. In this case the guns attached to the division of troops which is first to land must be put mounted into the boats, fitted as in No. 47. It is very desirable that this portion of the artillery should be embarked on board men-of-war, with the Officers and men attached to them; or if not the whole, at least the non-commissioned officers and a few of the gunners to look after the stores; the Officer and the remainder of the men joining previous to the disembarkation. Each two-decker can take a couple; the guns are stowed away on the upper deck, the carriages and wheels in the chains, so that the guns can be mounted and ready to be lowered into the boats in a very few minutes. The ammunition is to be taken out of the boxes, and placed in the magazine.

50. If the guns are on board transports, the boats may come alongside, and the guns be lowered into them as already described. The possibility of this occurring shews the absolute necessity of the battery being embarked by its own Officers and men, (see No. 3,) when the smallness of the transport's deck and her crowded state must produce great confusion.

51. The muzzle of the gun must point forward in the boat, and as soon as the boat takes the ground, the gang-boards are to be put out, and the gun run on shore, which can be done in five minutes in tolerably smooth water. At first landing the gun is generally drawn by sailors, an artilleryman guiding it at the trail; and it is therefore better that the limber should accompany the gun, which, with its ammunition, is then much more easily moved. When the limber is not with the gun, the ammunition must be carried by men, which is very fatiguing; the limbers should therefore follow as soon as possible.

52. The artillery should endeavour to gain the shore, and land with the troops, whose object will be to take up a position to cover the landing of the main body; and a sufficient supply of artillery ammunition and stores, in the common deal laboratory boxes, should be in a boat or two close to the shore. The landing is generally covered by the smaller frigates and by boats fitted with carronades.

53. By removing some of the forward thwarts of the boat, the planks for the gun-wheels can be laid with a slope, and one gun in a boat be fired to cover the landing; this slope should be about 3 inches to a foot, which will diminish the recoil to $1\frac{1}{2}$ foot. From these, two short planks should be laid, leading to the gang-boards; these may be fixed, or they may be laid after running the gun back; there must also be a centre

plank for the trail to recoil upon. The muzzle of the gun, when fired, must be well above the bow of the boat, so as not to shake it. This plan answers perfectly in the flat boats, which, though apparently slight, will stand a round or two very well. These boats are most useful; they are not high out of the water, and stores can be more easily embarked in them than in any others from a beach; but heavy stores are apt to damage them.

SECTION II.

OBSERVATIONS ON THE PROVISION FOR EMBARKING AN EQUIPMENT OF HEAVY ARTILLERY FOR A SIEGE.*

1st. The first things to be considered are, the place to be attacked, its strength, its position, whether distant or not from the spot where the disembarkation is to be effected, the ordinary means of transporting heavy ordnance and stores which the country possesses, and whether such may be calculated on with certainty and made available: all this should be entered upon, to arrive at the nature and extent of the equipment to be forwarded—not only as to the number and nature of ordnance and ammunition, but of the carriages and stores which are essential to complete this equipment in every particular, without encumbering it with burthensome and useless articles which experience and foresight may shew can be dispensed with.

2nd. The particulars of the equipment being thus decided on, one list in detail is to be prepared for the Executive Officer, or Storekeeper of the Ordnance, who is to furnish the supplies,—and the duplicate to the Superintendent of Shipping, who is to provide freight. The burthen, *i.e.* weight and measurement, of the whole equipment should be made out with as much accuracy as possible, so that such ships may be engaged as will give an ample, but not excessive, amount of stowage-room. Having thus arrived at the tonnage necessary for the whole, such a distribution should be made as may equalize the *quantities* and *description* of ordnance and stores which each ship should contain, so that in the event of any vessel being lost, there may be no undue deficiency in any one particular respect.

3rd. To arrive with some degree of accuracy at the tonnage required for the conveyance of a large equipment of ordnance and stores, considering the multiplicity of articles comprising it, varying extremely in weight and bulk, it appears to be an object of great importance that the Board of Admiralty should possess what may be called a Tonnage-Book, in which should be arranged alphabetically the weight, and measurement in cubic feet, of each piece of ordnance in the Service,—of those carriages, stores, &c., which are known as the indispensable accompaniments of each such piece of ordnance: the like arrangement may be made for Engineer stores. The labour of such a work would be much abridged by considering the various small stores belonging to each gun, &c., as being packed in one or more boxes or cases, of which the bulk and weight should likewise be entered in the Tonnage-Book: this would, moreover, enforce a regular system of keeping together the various small stores which belong to each piece, and would thus be immediately available, if necessary, on the latter being landed.

4th. In preparing for the embarkation, considering the Office arrangements as having been made by the allotment to each ship of the particulars which it is intended each shall receive, (their magazines to contain powder being carefully provided and in all respects ready,) whether a single ship or a dozen be necessary to contain the equipment, the plan for adoption which suggests itself to me as best, by combining expedition with accuracy, is as follows:

* By Mr. Butcher, Ordnance Storekeeper, Dulbin: and at the Siege of St. Sebastian, 1813.

Run the carriages with their ordnance stores and ammunition (not powder in any shape) upon the wharf, and arrange them by the side of the ships into which they are to be embarked; painters to be employed on the wharf in lettering each carriage and the boxes containing the respective stores with the name of the ship; and other artificers, for cleating iron-work on carriages and boxing linch-pins and washers when taken from carriages. Boxes containing case, grape, or spherical case, to be packed in separate stacks according to their nature; and the stores of a general character grouped together in such a manner as will admit of the whole being at once seen to be complete and ready to be shipped.

1st. The heavy guns, and mortars with their iron bed, as well as loose round-shot, which should be placed in the bottom of the hold, arranged on each side of the kelson, fore and aft, for the entire length.

2nd. The carronades and howitzers, which, being considerably lighter, should be placed above the guns and round-shot, but as nearly as possible in the centre of the hold, or plumb with the main hatchway.

For the better elucidation of my views of embarkation, see figs. 1 and 2, by which the ship's available stowage (after providing for the magazine) is *supposed* to be divided into 27 sections, *i.e.* 3 longitudinally and 9 transversely, which in every ship's bill of lading would be described in reference as larboard, centre, or starboard, from 1 to 9. The object in this is, I think, important; for as in many instances where a ship's cargo is not to be landed *in toto*, but certain stores only that may be urgently wanted, it is of consequence to know in what part of a ship they are be found, and thus prevent the serious trouble and delay which in my own experience has generally occurred for the want of some such arrangement.

Fig. 1.

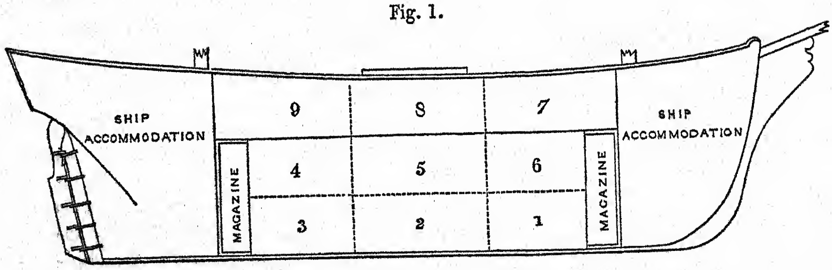
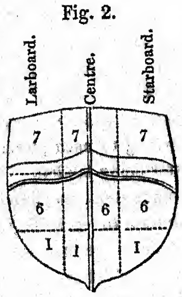


Fig. 2.



3rd. Having disposed of the ordnance and loose shot, the location of the remainder has to be considered with reference as much as may be to the trim of the ship, but more especially to the order in which the stores are usually required to be

disembarked; therefore the travelling carriages and the general stores as packed in boxes belonging to each piece should come next, keeping such stores always together, in order that in disembarking any one gun there should be no impediment to its instant completion.

4th. The store carriages, of all denominations, and all such general stores of a nature that cannot be required until the Engineer stores and the ordnance with their carriages and stores are landed, should be stowed, as far as practicable, together in the after part of the hold, thus providing for carriages on which to move the guns on being disembarked, and the stores immediately required for them, which should be with the guns.

The ammunition in boxes, such as case, grape, and spherical case, (care being taken that those for each calibre are placed together,) may be disposed of with reference to the trim of the ship, remembering to leave ample room for Engineer stores, which should be most immediately accessible, as being always first required.

Powder in barrels, or in filled cartridges, should be the last embarked.

In conclusion, it should be observed that the general rule for embarking stores is, "first wanted, last packed," with the exception of combustibles and powder, which, as above, must always be sent on board last; the ship's bill of lading furnishing a guide to the section of the ship in which any particular stores are placed, not with any critical accuracy, but as nearly as the eye can judge by the main dimensions of the space allotted for stowage. It admits of a doubt as to whether the course now recommended gives the most *compact* mode of embarkation by which *no* space will be lost; but it is conceived that the necessity of having everything at hand is paramount to all considerations of at best but doubtful economy.

SECTION III.*

EMBARKATION OF HORSES.

See Section I. 'Embarkation' of Field Artillery.

1. Horses require great attention at the time of embarkation, and while they are on board ship; and it is expected that every Officer of the cavalry will feel that he has a most important duty to perform on these occasions, on which depend, in fact, the means of his being usefully employed in the field, when he reaches his destination.

2. It is of the utmost importance to the future health of horses that they should not be heated at the time of embarkation. With this view it is desirable that a hurried march, on the day of embarkation, should be avoided; but as horses are much less liable to be injured by the operation of slinging after having undergone moderate exercise, and as they are then more disposed to be quiet and manageable than when fresh from quarters, their march previously to embarkation is to be regulated accordingly. They are to remain saddled until brought alongside of the ship, time being allowed for wisping them over and picking out their feet.

3. The breast and breech-ropes of the slings are to be made fast by an expert seaman, so that the knot, which is to be securely tied, may be easily loosened. The tackle is to be hitched on, and the horse run up quickly, in order that he may be deprived of the power of plunging and doing mischief. A web-headed halter with two reins, to be provided as ship's stores, is to be put on each horse before he is lifted from the ground, and the reins are to hang loose. The fixing of the guide-ropes, the bringing him over the hatchway, and conducting him through it, are to be done by the ship's company.

* From the Queen's Regulations.

4. When the horse is deposited in the hold, and released from the slings, it is the duty of the ship's carpenter to fix the bales which are to secure him: a lock of hay offered to the horse will tend to soothe his fears, and reconcile him to his new situation. As soon as all the horses intended for one ship are put on board and properly secured, they are to be fed with hay and watered.

5. On the first night of being on board, the horses are to have a mash with some nitre, and during their passage bran is to make a large portion of their daily ration. Care is to be taken that they are not heated by being over-fed: the small but sufficient ration allowed will guard against this evil; but judgment must be exercised in its distribution among the different horses.

6. The face, eyes, and nostrils of each horse are to be washed with a sponge and sea-water at the regular stable hours.

7. If a horse refuse his food, an early bleeding will in general restore him; but the object which, of all others, requires the greatest attention, is that the *hold* be well ventilated by means of wind-sails, the ends of which ought to be at different parts of the hold, and the number of them in proportion to its size and depth. A proper supply of pure and fresh air must be secured.

8. In cases where, from bad weather or other causes, the hold has been kept more than usually close, great advantage will be found in washing the manger with vinegar and water, and occasionally sponging the nostrils of the horses with the same.

9. It is necessary that at least one stall on each side of the transport should remain vacant, and some spare canvas is to be provided for slinging the horses to the bales between them in case of illness or accident.

10. After disembarkation, a cooling moderate regimen and gentle exercise are the best means of restoring the horses to their wonted vigour, and preparing them for service: indeed they should be treated with the same caution as is observed in regard to Remount horses.

SECTION IV.*

DISEMBARKATION OF INFANTRY.—REGIMENTAL ARRANGEMENTS TO BE MADE.

The arrangements necessary will depend much upon the service to be performed, and the intent with which the men are landed. In some cases they are thrown on shore for a few days or weeks, only retaining the line of *sea-coast* as their base of operations. In others, they are landed for permanent operations, when, though they may still draw some of their supplies from the shipping, they cease to consider the fleet as their refuge from defeat and the storehouse for their daily supplies.

For temporary and flying operations along a coast, the men should be landed as light as possible, and no *baggage*, mules, or horses should be allowed to encumber the movements of a force liable each moment to be re-embarked, either to relinquish the operations altogether, or to effect a fresh landing at some other point. Men and Officers, therefore, must carry only what is absolutely necessary to enable them to exist and do duty; and this depends very much on the state of the weather and the height of the thermometer.

At a temperature by day from 50° to 70°, the soldier's equipment should be the clothes he stands up in, with a knapsack containing 1 great coat, 1 pair of stockings, brushes, soap, and towel; rags for cleaning musket, and 40 rounds of spare ball ammunition; and in this case he lands in cloth trousers.

At above 70°, he should land in white trousers, and take his cloth ones in his pack

* By Captain Rea, Royal Marines.

for night service; for I have seldom seen men fresh from a ship able to undergo much exertion in warm weather, if too heavily clad.

Under 50°, service of this nature should not be attempted unless you can give men either tents or blankets.

The first duty of the Regimental Officer is to see that the men do not take more clothing, &c., than is ordered. He should next have two days' meat *cooked*, and issue that and four days' bread, taking with him the usual proportion of small-sized camp kettles and cutting tools.

The rations of wine or spirits should not be issued to the men, but must be put in convenient-sized barracoes, and carried by men told off for the purpose, until better means of conveyance (such as carts or horses) can be seized from the enemy or hired of the peasantry. About 4 men per company of 70 men should also be provided with bearers for the conveyance of wounded men and for the supply of stores, &c.; these men should not be armed.

When ordered to land, Commanding Officers should if possible have accommodation-ladders shipped, as it is a very slow process getting troops into boats without them. If opposition is expected to the landing, the muskets may be loaded before leaving the ship, but should not be primed for fear of accidents (speaking of detonators); they must prime in the boats; but packed as troops usually are for landing, they could scarcely load in the centre of a boat.

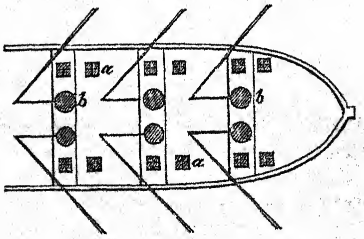
A proportion of officers and non-commissioned officers belonging to the company should go in each boat; and no company should be broken up more than is absolutely necessary; they should be told off as a company before leaving the ship.

The Officer commanding the troops in the boat should be in her *bow*, ready to jump out when she touches the beach, and a non-commissioned officer should be in the stern, to hurry the men in clearing her.

In getting down a ship's side without accommodation-ladders, the men should slip the hand between the sling and musket just below the top swivel, so that the musket hangs by the wrist; this allows both hands for the side-ropes: the sling is not to be loosened out.

The first men in the boat must be made to move to her bow and stern, and not allowed to crowd in the centre, which they are very apt to do, and which causes very great delay. Old hands will generally avoid going into the bow of the boat, for fear of a wetting; the best remedy for this is the example of the Officer.

If there is any motion, care must be taken not to overload the boats, for fear of their swamping; there will therefore be *room* for the crew to pull. As many of the troops as possible must be made to sit down in the boats: in a barge or pinnace one soldier between each rower and the rowlock, before the oar, looking aft, and one abaft each oar, with his back to the gunwale, thus:*



* The ◯ are sailors, the ⊞ are soldiers.

In launches or larger boats there will be room for men to sit or stand in the centre of the boat between the two lines of rowers, in addition to those marked for barges, &c. The head and stern sheets of old boats to be packed as close as possible consistent with safety.

If the water is perfectly smooth, the boats may be laden much deeper, the men standing as close as possible together; but in this case they must be towed, for two reasons: 1st, the crew have no room to pull; 2nd, when boats are very deep, the men cannot get the blades of the oars out of the water so as to pull with effect. It must, however, be remembered that it is slow work towing a heavy boat by a light one; load, therefore, the boats employed in towing as deeply as you can without inconveniencing the rowers.

Boats employed in landing troops are to have neither guns, masts, nor sails; their equipment to be—gang-boards, oars, grapnels and painters, boat-hooks, bailers, hammers and nails, sheet-lead, grease, and canvas; the latter articles are to enable them to stop a small shot-hole in case of accident.

The number of boats to be sent in *a body* to the shore must depend on the quantity of beach disposable for landing. Suppose there is 100 feet of beach, and that the boats take 10 feet each. If more than ten boats are sent together, they make confusion at the landing-place between light boats coming out and loaded boats trying to get in, in narrow beaches: therefore throw the boats into divisions of ten, and start them thus in succession, so that the one division should land their men and be clear off the beach just as the next arrives. To insure regularity in this, it is indispensable that there should be an Officer of *rank and authority* as *Beach-master*, and another afloat, superintending with the fleet.

When the place for landing has been determined upon, don't stand looking at it; get the men into the boats ready to pull in, send in your small craft and *armed* boats to open a fire on the spot, particularly any cover within musket-range of the beach, in two lines abreast; but once the men come under fire, they will always exert themselves to get in: the fastest boats therefore will reach the beach first; nor is it any inconvenience that one boat should be 40 or 50 yards before another.

Landing in a surf is always a dangerous and difficult operation,* nor can any general rule be laid down, as plans that succeed at one place are found to fail at another: the opinions of experienced Naval Officers should be taken, and also the advice of persons acquainted with the locality. You must not expect to keep your men dry in landing through a surf. Take care the boat does not come broadside on *while in* the surf: after she is beached it is of less consequence. Flats are better than keel-boats for that purpose. The best general instruction that can be given is to watch the sea, and go in on the *top* of the highest surf, flinging your long painter on shore as the boat goes in. Men on shore must seize it, and run the boat up as high as possible, and hold on to prevent her being drawn out by the reflux. The men must jump out as quickly as possible after the water leaves her, for the next sea will, if she is deep, probably fill her.

Should the next sea lift her stern, haul on the painter and get the boat as high up on the beach as she will come. If she be thrown broadside on to the surf *while* her bow is well up on the beach, it is seldom of much consequence, provided the men jump out quickly, and she is not allowed to fall over with her bottom towards the shore.

It is to be recollected that this arrangement is for the infantry landed for tem-

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* See latter part of Section V.

porary service, without baggage, guns, or stores, and opposed only by troops or guns in the open field, and not protected by works of any kind.

They must be very liberal with round, grape, and canister, and under cover of the fire the boats should pull boldly in, recollecting that the men are to be landed, and that the sooner it is done the better; the fire of the shipping only ceasing when there is danger of injuring the wrong men.

The men in the first division are, of course, those to be depended on; and the Officers having been shewn their ground, as the boats approach the beach, each should select the best shelter he can to form his men under; this he will frequently find just above high-water mark, where the sea generally leaves a small ridge.

As soon as the boat grounds, the Officer jumps out over the bow, followed by the men as quickly as possible, taking care that they do not all rise up together, or jump out over any part of the boat but the *bow*. If the boat is large, or there are rocks so as to render it unsafe for an accoutred man to jump, the gang-boards must be used, the men quickly following the Officer away from the water's edge to the sheltered spot he has selected for his formation, from whence he must open fire or advance at discretion, without waiting to be joined by the men from other boats: he is to consider himself part of a line of skirmishers, the supports of which line are in the second division of boats.

As soon as each boat is clear, she must shove off and pull to the shipping for a fresh cargo; waiting, when full, alongside of the ship for the rest of her division of boats.

The second division of boats will land as the first, getting the best shelter they can to form, but they will not commence firing until the whole of each company has joined, when they will act as supports under the command of their proper Officers, or according to circumstances.

As soon as a sufficient number of completely-formed companies are on shore, the irregularly-formed skirmishers first landed will be relieved, formed, and sent to their respective battalions.

As the advance gets sufficient room for the points of formation (for battalions must be such a distance from the beach as to prevent confusion at the water's edge), steady non-commissioned officers will remain on the beach to instruct the men of their respective regiments in what direction to go on leaving the boats.

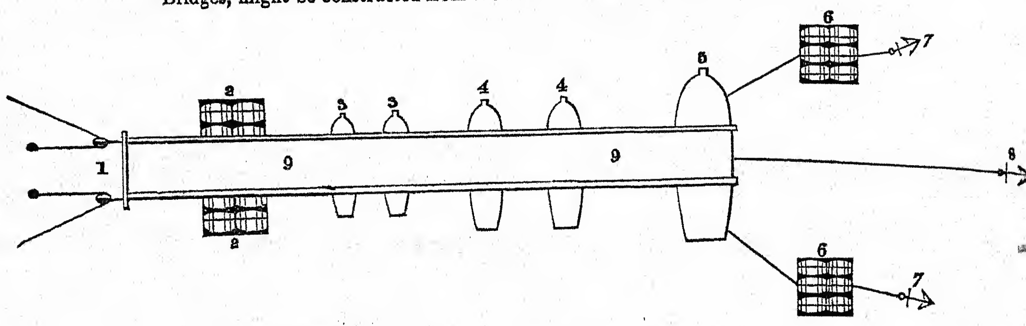
A very small space suffices for landing, but should it be greater, more boats will, of course, touch the beach at one time, and then it will not be necessary for *all* the men first landed to be thrown out to skirmish, but the troops of a certain number of boats will be told off for that purpose; the remainder forming regularly. It should, however, be particularly noted that no time is to be lost in striving at too much regularity; a certain number of the men first on shore must always dash on as soon as possible to gain cover and room for those that are to follow.

For landing provisions, stores, and guns, seize some small convenient pier, or failing that, erect good substantial derricks (see 'Derrick'), recollecting that the shipping abound in spars, rope, blocks, &c., &c., necessary for the purpose.

The best description of carpenters, smiths, ropemakers, sailmakers, are to be had from on board ship.

See 'Bridge.' Plate VIII.

It is conceived that for the purposes of landing troops and stores, a half of a bridge, similar to some of those described in Sir Howard Douglas's work on Military Bridges, might be constructed from the boats of a line-of-battle ship, thus:



1. Bridge end fastened to the shore.
2. Raft of casks in the shallow water; the end next the beach to be protected with fenders of bags of oakum, or fascines, to prevent the heave of the sea from staving the casks by thumping them against the bottom.
3. Ship's cutters.
4. Pinnace and barge.
5. Launch.
6. Two rafts of casks, capable of bearing about say 6 tons each, hove partly under water, so as to act as a *spring* on the bridge and keep all taut, and also to prevent a downward strain on the outer boat, these rafts bringing the strain parallel to the surface of the water.
7. Heavy anchors, with a long scope of cables, say 100 fathoms each of 8-inch hawsers.
8. Anchor for hauling out the bridge on the fall of the tide, so as to keep the raft at the inner end always afloat: this hawser to be slacked up when a vessel goes alongside the bridge end.
9. Two-inch deals, 10 feet long, laid on five 6-inch hawsers. To form the roadway of the bridge, the planks must be 2 inches apart, to allow the sea to wash between them, and prevent their being blown up.

Oars, boats, masts, and small spars, should be laid, running the whole length of the bridge, lashed over the ends of the planking to the hawser beneath, to prevent too much spring in the bridge.

Such a structure, from its being very *flexible*, would, it is supposed, stand a considerable sea.

Small steamers might go alongside the end of it, while boats could put men on its side.

ADVANTAGES.

Fifteen feet of beach or rock is all that would be required; small spots, therefore, might be selected for a landing where the enemy had no troops. Generally, wherever the beach is extensive for a landing, a strict watch would be kept; but it is impossible to watch every small nook of from 10 to 30 feet landing-place.

Such a structure might be put together out of gun-shot, and towed in: with proper drilling, half an hour would probably anchor it and secure all taut.

In re-embarking there would be no danger of the boats becoming hard and fast ashore on their being loaded, which sometimes takes place now, and men are at times obliged to land again to get a boat afloat.

In re-embarking under fire, the rear-guard might run on the bridge and cut it away, and take their chance of being towed out of range by a steamer.

With such a structure, a force would land in one-tenth of the time now requisite to land them in boats.

When one of Blanshard's large bridges is embarked, and is not immediately required for operations on shore, it might be thus used.—*Ed.*

SECTION V.

FRAGMENTARY NOTICES OF NAVAL ARRANGEMENTS FOR DISEMBARKING TROOPS.*

In landing without opposition, advance in line abreast, with as few men in the bow of the boat as possible, which will enable her to be laid high on the beach, and prevent the men from getting wet.

When opposition is expected, the troops intended to be landed from men-of-war or transports, in an enemy's country, should have on the previous night three days' provisions ready cooked and served out as they are leaving the ship. When in the boats, they should rendezvous at the nearest ship in-shore; when ready, advance in line, covered by the launches and all other boats carrying guns, and flanked by frigates and brigs as the water will allow. A Subaltern's party should be named to advance to an height, to observe what is going forward while the battalion is forming, which will then advance and leave the beach clear for the next detachment.

N. B. All boats should be provided with a grapnel or small anchor, with 15 fathoms of rope, to be let go on approaching the beach, so as to be able to haul off when required.

Any number of soldiers that can be conveniently carried without lumbering the oars or loading the *bow* may be stowed in the boats.

All boats should be provided with two buckets for baling in the event of their being struck by shot, in which case a tallow plug, or a seaman's jacket, should be quickly placed in the hole: should there be extra ammunition in the boat, it should be removed into the stern-sheets and kept dry.

When the launches and pinnaces, &c. are entirely filled with troops, they should be towed by as many *small* boats as can be spared from the fleet.

Each boat should be furnished with two planks that would stow between the after-thwart and head-sheets: or if this cannot be done, let them be slung over the gunwale. These planks, when nailed to a batten on each end, will enable the soldier, who at all times is heavily laden, to have confidence to embark or otherwise without wetting himself.

All men-of-war boats have gang-boards, which will answer when you cannot get broader ones.

LANDING ON SURF-BEACHES.

Troops cannot be landed in a heavy surf without great risk. The boats of the country where the service takes place will answer better than our own (perhaps), and, if they do, I should take the liberty of borrowing a few for a short time.

But I should push for a river or get within a reef, if possible. Beaches defended by surfs are generally accessible before sun-rise in *moderate weather.* You can land at Madras between 4 and 5 A.M.; by 10 you could only approach it in a Masula boat.

On these beaches there are generally running three heavy surges; if you place your boat on the back of the last, and let the men *pull for their lives*, you may reach

* Gleaned from the correspondence of an old Naval Officer.

the shore,—always keeping her *before* the *sea*, and on no account allow her to broach-to. The moment the boat takes the beach, jump out, and haul her up before the next sea breaks.

SECTION VI. A.

INSTRUCTIONS FOR THE CAPTAINS COMMANDING DIVISIONS, ON LANDING THE TROOPS.*

H. M. S. *Ajax*, 24 Jan. 1801.

When the troops are to be landed by the boats of the fleet, great care should be had that they are kept at a proper distance from each other, at least 50 feet; and when the situation of the place will admit of it, they are to dress, or take their respective stations, from the right, otherwise from the centre, or left, as may be most convenient, or as shall be previously appointed.

On no account must the boats crowd upon each other, nor are they to break the line, either by getting too much ahead or astern.

No boats are to come into the first line except the flat boats and the launches having the artillery on board; these last, towed by cutters. The second line is to be composed of cutters only, to attend upon the flat boats, that they may afford immediate relief, should any boat require it, in which case they are to proceed directly, without waiting for orders to give the necessary aid. The third line is to be composed of the cutters that tow the launches, and the boats belonging to each ship will keep in the wake of their respective flat boats.

To distinguish the boats having on board the Grenadier company of each regiment, they will carry the camp colours of that regiment, and the other boats are to form to the left, until the regiment is completed, taking care that the companies are embarked on board the boats in the order they should be in when landed; and the Captains commanding the divisions will consult with the Commanding Officer of the troops, and fix on the best method to obtain this object without confusion.

When the troops are to land, a situation will be pointed out upon the shore, where either the right or left will proceed to: if from the right, the boats to the left must observe open order, that the right wing may not be too much crowded together; and the boats to the right will pay like attention when the left is the point from which they are to form.

Upon no account must any flat boat be nearer to another than 50 feet, and this will afford sufficient space for the cutters and launches in the rear to land between the flat boats, agreeable to regimental order of the troops they have on board.

The flat boats are always to drop their grapnel from their stern at a proper distance from the shore, that they may haul off the moment the troops are landed.

It may often be necessary that the flat boats should pull quick round into an opposite direction, either for retreat or any other cause, in which case it is of the utmost consequence that they should do so together, and in one direction. Strict attention must therefore be paid to the signal that will be made upon that occasion; and if no signal is made, they are always to pull to starboard.

The Captains commanding the different divisions will repeat all the signals by the Commanding Officer of the disembarkation; and each Captain should have a rowing-

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* Section VI. A. B. C. from the 'History of the British Expedition to Egypt,' by the late General Sir Robert T. Wilson.

boat attending him, with a careful Officer to carry his orders to the boats of his division.

In order that the flat boats may observe the signals as soon as made, a musket will be fired from the Commanding Officer's boat, which is to be repeated by the Captains of the other divisions. Each boat having the signal-flags on board must be provided with stretchers, that the flags may be seen should the weather be calm; and all signals will be made at a flag-staff in the centre of the boat.

The Officers commanding the boats must take particular care that none of the troops stand up, as on many occasions it may endanger the safety of the boat.

Each flat boat must be provided with four or five breakers, or small casks of water, that immediate relief may be given to the troops upon their landing, should they require it.

When the first landing is completed, the boats (when ordered) will proceed to those ships having ensigns at their fore-top-gallant mast head; afterwards to those having their ensigns at the mizen, until all the troops are on shore.

When the second landing takes place, the Captains will proceed with their divisions of boats to particular ships, that the regiments may be landed in a collective body; and this is to be observed until all the troops are on shore.

The launches that landed the artillery will proceed to such ordnance ship as will be pointed out, to land the light artillery and stores. Should this service not be requisite, they will assist in disembarking the troops, agreeable to the last instructions.

The Captains of the different divisions will deliver copies of these and all other instructions to the Lieutenants under their orders; and they will give theirs to the Midshipmen commanding the flat boats.

No persons belonging to the boats to be permitted to quit them upon landing, unless by the particular order of the Commanding Officer of the division.

SECTION VI. B.

ADDITIONAL INSTRUCTIONS FOR THE CAPTAINS AND OFFICERS APPOINTED TO SUPERINTEND THE DEBARKATION OF TROOPS, &c.

The Commander-in-Chief having signified to me, that after the troops are landed, the boats under the directions of the Captains of their respective divisions are to be employed in landing the stores, provisions, and water belonging to the army,—

The following distribution of the boats is therefore to take place, in order that the demands made by the different departments of the army may be regularly complied with.

After the first landing is completed, and ten pieces of artillery are on shore, the launches are to repair to the following ships, and convey on shore the guns as expressed against them.

	Launches.	Guns.
Foudroyant . .	2	2 6-pounders, *Monarch* transport.

Should the *Minotaur* and *Northumberland* not join, the following boats will land four howitzers, viz.

	Launch.	Guns.	
Swiftsure	1	1	From the *Monarch.*
Diadem	1	1	
Ajax	1	1	From the *Indefatigable.*
Europa	1	1	
Kent	1		To be employed in landing spare ammunition, hand carts, &c., from any of the above vessels that are most convenient.
Dictator	1		

A vessel will be anchored near the shore (having an Ordnance flag flying), on board of which will be the spare ammunition, &c., independent of what will be landed by the *Kent* and *Dictator's* boats.

And the following launches will proceed on board the *Ann* transport, and there receive on board such stores as the Commanding Engineer may direct, viz.

	Launch.	
Stately	1	With cutters to tow each.
Northumberland	1	
Delft	1	
Minotaur	1	

When the whole of the infantry are landed, and the above service completed, the divisions under the command of Captains Stevenson, Morrison, Larmour, and Apthorpe, assisted by Captain Gunter, P. A. T., after placing dunnage in the boats' bottoms, are to be employed in landing the cavalry of the reserve, consisting of 234 men and horses; also General Finch's brigade, consisting of 252 men and horses, making in all 486 horses with their riders, and for which 48 flat boats will be necessary: when they are landed, the boats are to return and land the horses belonging to the artillery, amounting to 182, and 86 men; also those belonging to the staff of the army, about 120, with their keepers; also such a proportion of forage as shall be judged necessary. After this service is performed, Captain Stevenson's and Morrison's divisions will be employed in landing water and provisions, to be deposited in the situations pointed out by the Commissary-General. All the vessels not employed by Captain Larmour in the Ordnance department will be dedicated to this service, particularly for the conveyance of water from the fleet to the army, should they require it, which is likely to be the case.

When the whole army is disembarked, Captain Larmour's division, with the launches that land the guns, except such as may be ordered to act as gun-boats, are to be exclusively appropriated to land all the ordnance and stores, together with those belonging to the Engineers' department in this service. Captain Larmour will be assisted by Lieutenant Kemp, the agent for those departments.

See latter part of Section IV.

It will therefore fall directly under the direction of Captain Larmour to have proper wharfs erected for the stores being landed upon (applying to the Admiral for carpenters); that the boats are fitted for the reception of the heavy guns; slides provided to roll the guns out on; a proportion of 2-inch planks to be taken in each boat, for the trucks or wheels of the guns to run on when landed; and afterwards to accompany the guns, to prevent their sinking in the sand, should it be judged necessary; purchases prepared for getting the guns up on the shore, anchors sunk in the sand in situations proper for hauling the boats up by, in the event of bad weather, and such further precautions as may be judged necessary: some decked vessels will be placed under his directions, for the conveying of such stores as are liable to receive injury from the weather, as well as for the transportation of fascines, palisades, &c., &c.

Captain Scott's division, after the last brigade is landed, will disembark the dismounted dragoons, in number about 751 men; also the pioneers of the army, nearly

400 men; after which, should it be necessary, they will assist in the same service as Captain Stevenson's division; and on these duties Captain Scott will call to his assistance Lieutenant Brown, Agent for Transports.

Captain Apthorpe will, after the troops are on shore, employ his division in landing the stores belonging to the general hospital; also those that appertain to Quarter-Master-General departments, and such others as do not fall under those heads already mentioned; but should those stores be soon landed, Captain Apthorpe will employ his boats on any other services where the demands are most urgent.

As it is quite impossible to foresee the different duties that must be performed by the boats of the fleet, and from the variety of situations I may be in, during the course of the intended service, it may not be in my power to give all the necessary orders; the Captains of the different divisions must therefore exercise their own judgments upon many occasions. I shall only recommend that where any service is demanded by the heads of departments, that the same be complied with; but on all occasions, those orders that come immediately from the Commander-in-Chief of the army, the Adjutant-General, or his deputy, Colonel Abercrombie, the Quarter-Master-General or his deputy, are to have the preference.

Care must be taken that the boats' crews are regularly relieved when the service will admit of it, in order to prevent sickness from over-fatigue, or being too long exposed to the sun.

The boats' sails, when they have not awnings, are to be spread over them, when it can be done with convenience, both to afford shelter to the men and to prevent the sun from rending the boats, which will be greatly assisted by their being frequently wetted, particularly in the evening, except when the men are forced to sleep in them, upon which occasion doing it in the day-time is to be preferred.

The flat boats are not to be employed on any duty where they are liable to injury, and the utmost care must be taken to keep them in constant repair; upon which account it is recommended that a carpenter shall be sent from each ship as one of her crew, being provided with a hammer, an assortment of nails and materials proper for stopping shot-holes,* or affording a temporary repair to the boat. These carpenters may be occasionally employed upon fitting wharfs, or other necessary services.

When any wounded men are brought down upon the beach, and a request shall be made for their being conveyed on board the hospital ships, the Captain of the division to which such application shall be made is to direct some of the boats under his orders to perform the service, and if necessary that the flat boats shall be removed, that the soldiers may be placed with convenience and ease to themselves, directing cutters or other boats to tow them. This service is particularly directed to the attention of Captain Apthorpe, whose division is attached to the Medical department.

Three days' provisions must be ready cooked for the crews of the boats, and each of the men provided with a blanket, one shirt, and a pair of trousers.

Every flat boat to have two spare oars, and a set of wooden thoels with grummets, in case the others should be lost or broken.

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* Thin sheet-lead, thin plank, sheathing-felt, oakum, tallow, &c., or (as in Sect. V.) "a seaman's jacket."—*Ed.*

SECTION VI. C.

*General Orders.** Head-Quarters, Marmorice,
H. M. S. *Kent*, February 16th, 1801.

Such Officers' horses as were not embarked on the 14th instant will be on the beach ready for embarkation to-morrow morning, at 8 o'clock precisely. Officers will take notice, that after to-morrow no horses will be embarked.

The horses which have arrived for the cavalry since the last allotment are distributed as follows:

11th Light Dragoons	4 horses	On board No. 1.
Hompesch's . . .	17 do.	
12th regiment . .	16 do.	On board No. 21.
26th do. . .	11 do.	

These horses will be on the beach ready for embarkation to-morrow morning, at 7 o'clock.

The horses will receive the following rations while on board ship, viz. 5 ℔s. of barley, 5 ℔s. of straw, and 3 gallons of water. As it has been impossible to supply all the horse vessels with weights and measures, the non-commissioned officers will use the Turkish steelyards, which they will find on board, taking notice that the *Turkish ocque* is equal to 2 ℔s. 11 oz. English; so that the rations for horses at present established will be two *ocques* of barley and three *ocques* of straw, nearly.

Majors of Brigade are responsible that a copy of this Order, as well as that of the 6th instant, is given to each of the non-commissioned officers in charge of the forage and provisions on board the different horse ships.

As nearly as circumstances will permit, the disembarkation of the army will take place in the following order:

1st. The Infantry of the Reserve, with 10 pieces of light artillery.
The Brigade of Guards.
The remainder of the first line, with 6 additional pieces of light artillery.

2nd. The Infantry of the second line.

3rd. The mounted detachments of Cavalry of the Reserve and Brigadier Finch's brigade.

4th. The dismounted part of the same brigade.

5th. The pioneers of the army, the horse detachment of the Royal Artillery, and such additional pieces of ordnance and ammunition as may be wanted.

When the troops are ordered to land, the men are to be put into the flat boats as expeditiously as possible, but without hurry or disorder: they are to sit down in the boats, and in rowing to the shore the strictest silence to be observed: *the troops are positively ordered not to load till formed on the beach;* the formation is to be effected as soon as possible; the men are to fall in, in line, opposite to where they land; nor is any individual or body of men, in conceiving themselves displaced, to attempt to regain their situation by closing to either flank, till ordered so to do by the General Officer on whom they depend, or the Senior Officer present on the spot.

The troops are to land with sixty rounds of ammunition per man; the ammunition which cannot be contained in the pouches to be carefully put in the packs. Three days' bread and three days' pork, ready cooked, is to be carried by officers and men: the same quantity is to be landed to the troops; it is not, however, to be de

* Abridged.

livered out, but carried in kegs, and put under charge of the Quarter-Master of each regiment, with a party sufficient for the purpose: each man will carry his canteen filled with water.

Three days' barley will be carried for the horses of the cavalry, and of the Staff and Field Officers.

The Staff and Field Officers must provide themselves with forage-sacks previous to the fleet sailing from this.

The men will carry their intrenching tools, and the proportion of necessaries specified in the Orders of 15th August last, viz. 2 shirts, 1 pair of shoes, 2 pairs of socks or stockings, neatly made up in their packs or knapsacks, their camp kettles, and blankets. Regiments having both blankets and great coats will leave the latter on board.

It is absolutely necessary that the Officers should bring on shore in the first instance such articles only as they can carry themselves. Officers' servants are not only on all occasions of service to be present under arms with the corps to which they belong; but they are to carry no more than any other soldier, and are to mount all pickets and guards with their masters.

The smallest number of bâtmen possible will be permitted; mounted Officers alone are entitled to them.

The music, drummers, and men least fit for actual service, are to be selected for all regimental duties not purely military; and Officers commanding corps will be held strictly responsible for their being at all times, and in every situation, in the most effective state.

A proportion of the general Hospital Staff must be attached in the first instance to each brigade, and will be allowed such orderlies as are absolutely necessary from the brigade. Regimental Surgeons are to be allowed one orderly each, to carry the field case of instruments.

The spare arms, tents, and horse appointments of the dismounted cavalry, and every article of spare baggage, are to be left in charge of a careful non-commissioned officer on board of each ship.

After the troops have landed, the sick of such regiments as are embarked in transports are to be collected into one of the vessels occupied by the corps, under the care of the Assistant Surgeon, who will, as soon as possible, report himself and the state of the men under his charge to the Inspector-General of Hospitals on board H. M. S. *Niger*. In case of there being only one Medical Officer present with any regiment thus situated, this duty must be assigned to a careful non-commissioned officer.

Regiments embarked in men-of-war will leave the sick under the care of the Surgeon of the ship, who will be entitled to the allowance established in such cases. If necessary, a small proportion of orderly men may be left with the sick, to be selected from the convalescent men: regiments that have women will employ nurses in lieu of orderly men. The women are positively prohibited from landing on any pretence whatever until the Commanding Officers of corps have obtained the Commander-in-Chief's express permission for that purpose.

Detailed instructions relative to the Artillery, Engineers, and Commissariat, will be communicated to the respective heads of those departments.

SECTION VII.

On referring this important article to a distinguished Naval Officer who was employed in the Chinese seas, he declined contributing the necessary information on

account of the impossibility of defining precisely what is to be done in regard to embarking and disembarking troops under fire,—these operations depending upon local circumstances; and because that, before orders can be issued, a careful reconnoissance must be made of the place proposed for the point of embarkation and disembarkation,—how it is protected,—how near it can be approached with vessels of light draft of water to scour the beach and cover the boats,—what description of boats are at command,—the number of men to be landed and taken off, &c.*

But assuming that these preliminary questions are provided for, the details and precise arrangements for the embarkation and disembarkation of *troops and stores* are desirable; therefore, in order to give every information possible, the best authorities attainable have been selected, as given in the preceding Sections.

For ordinary circumstances, and every-day occurrence to British soldiers in their tour of foreign and colonial service, the Queen's Regulations should be consulted, commencing at page 325 and ending at 369, third edition.

The introduction of steam to maritime war affords facilities of transport, and the means of covering a landing or re-embarkation, not available before; but these additional means do not give the actual operations any greater facilities than before, as the men and stores are still to be placed in boats adapted to the local circumstances.

For distant operations, the long boat of the transport and the launch, barge, and pinnace, are the only resources which have hitherto served the purpose; and flat-bottom and other boats constructed expressly for the landing of troops are difficult to carry, and rarely found at the point of debarkation.

The British soldier, after a few weeks afloat, acquires a certain degree of handiness, and what is termed his 'sea legs;' he will then profit by the hints offered in Section IV. of this article, written by Captain Rea, of the Royal Marines.

The landing in Egypt in 1801 is given in Section VI. as an example of a debarkation of a large force, as extracted from Sir Robert Wilson's 'History of the British Expedition,' fourth edition. The force landed was probably the largest (5000 men) ever

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* The following memoranda for reconnoitring previous, or for report subsequent, to a landing, may be useful and acceptable.

CÔTES.

"La nature des côtes, bordées de dunes, couvertes de rochers plats qui rendent leur abord plus ou moins dangereux; hérissées de falaises qui en interdisent absolument l'accès—les parties développées et découvertes propres aux descentes—les parties rentrantes offrant des anses et des ports—les pointes et les caps propres aux forts, aux batteries, qui pourront défendre les points accessibles—les îles adjacentes servant d'ouvrages avancés qui forment des barrières aux tentatives de l'ennemi—les laisses—les anses—les baies—les rades—les ports; la nature des vents qui sont nécessaires pour l'entrée et pour la sortie de ces ports, dont il faut indiquer les avantages et les inconvéniens—les différentes batteries établies pour la défense des mouillages, des passes—les retranchemens, les épaulemens pratiqués dans les parties où l'on peut tenter les descentes—les camps, les postes qui doivent couvrir les principaux établissemens et l'intérieur du pays—exposer tout ce qui caractérise les endroits accessibles; les dangers qu'on aura à courir; les obstacles à surmonter; les moyens de les augmenter, les temps des marées plus ou moins favorables à l'approche des endroits. Indiquer les lieux donnant des positions plus avantageuses aux moyens de défense et aux points à défendre—l'état actuel des forts qui protégent la côte; des batteries; des corps-de-garde et de toutes les pièces d'artillerie qui peuvent s'y trouver—analyser les systèmes de défense donnés; les améliorer, en faire un nouveau—calculer les forces que peuvent fournir, dans un moment de surprise, les canonniers gardes—côtes, en attendant que les troupes réglées de tels et tels lieux puissent arriver aux points attaqués.—S'il est des rivières qui aient leur embouchure sur ces côtes; les marées apportent des variations sur leur passage; il faut rendre un compte exact de cette influence."—*Aide-Mémoire à l'usage des Officiers d'Artillerie de France.* Tome second, 5th ed., p. 1152.

thrown on shore at one time, and the whole of the arrangements appear as perfect as they were successful, and serve as a beautiful study for similar operations.

In reviewing the important points embraced by this subject, and recapitulating the Sections of this article, which comprise, as regards *Embarkation*,

First, the deliberate and careful stowing of the Artillery, Engineer, and other stores, to be placed in the vessels in the order of probable wants, and so as easily to be got at; as explained in Sections I. and II.;—

Secondly, the embarkation of the horses and troops;—

Lastly, the economy and management of the whole afloat, which are especially provided and explained in the Queen's Regulations;—

In the *Disembarkation*, the horses and troops become the first for consideration: the men to be placed in boats, the horses swum to shore, and a few pieces of light artillery dragged on in the first instance by seamen: otherwise the first operation in embarking is the last in the disembarkation: the final one will, of course, depend upon the Objective Points of the expedition to be attained. G. G. L.

DISINFECTION.—See 'Sanitary Precautions.'

DIVING BELL.*

DESCRIPTION OF THE DIVING BELLS AND MACHINERY, &c. USED IN THE ERECTION OF THE NEW PIER AT HOBBS' POINT, MILFORD HAVEN.†

There were four bells employed, which I shall describe separately, as they all varied either in size, shape, or material.

Diving Bell, figs. 1, 2, 3, and 4.—No. 1 diving bell was made of cast iron, 6 feet 2 inches long, 4 feet 6 inches broad at the bottom (on the outside), and 5 feet 2 inches high; the sides and ends were 1¾ inch thick at the top, and 2¾ inches thick at the bottom; the top of the bell was 1¾ inch thick, and strengthened by a strong longitudinal iron rib, to which the block of the fall was shackled: there were also six transverse ribs, three on each side of the longitudinal one. This bell was not quite flat at the top, but rose 3½ inches from the sides towards the centre, and was cast in one piece; it weighed 4¾ tons. On the top were ten convex lenses, 8 inches in diameter, fitted into a rabbet formed in the casting, having an iron rim screwed round them on the inside of the top of the bell to secure them: these lenses admitted sufficient light, when the water was clear, to distinguish the smallest objects (which I have been enabled to do when in the diving bell 54 feet under water).‡ Air was supplied to the workmen employed in it through a leather hose, one end of which was screwed into the centre of the top of the bell, and the other into the receiver of an air-pump worked from above. The hole that admitted the air was covered on the inside of the top of the bell with a piece of circular leather, secured by eight screws, in the spaces between which the air entered and spread, avoiding thereby an unpleasant direct current. This piece of leather, should the hose burst, would also prevent any very great quantity of water from entering the bell instantly, and there was always sufficient air in it to support the workmen till they could be raised to the surface. On the outside of the bell, at each

* From 'Professional Papers,' vol. i.

† By Lieut.-Colonel Savage, R. E.

‡ The foundation-stone of the pier is 57 feet under water at the highest spring tides.

Fig. 1.—Side Elevation.

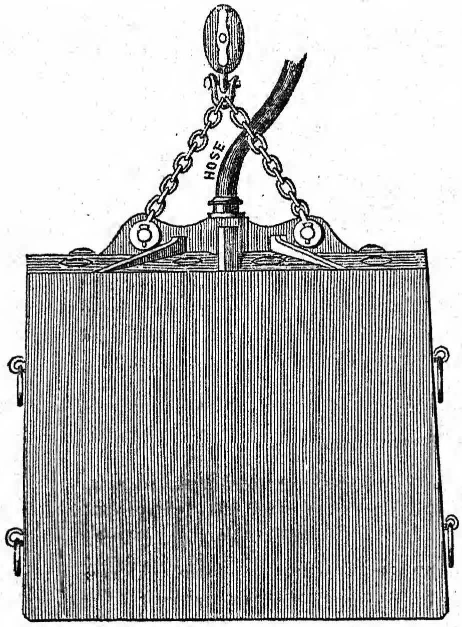


Fig. 2.—Section.

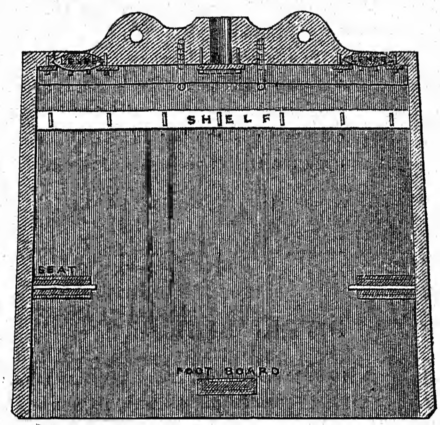


Fig. 3.—Outside Plan of the Top.

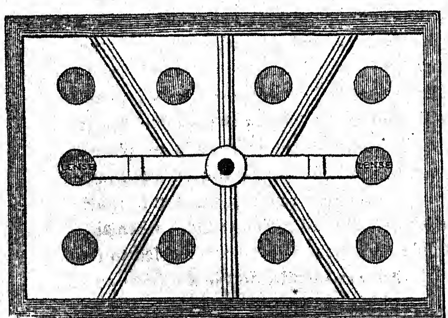
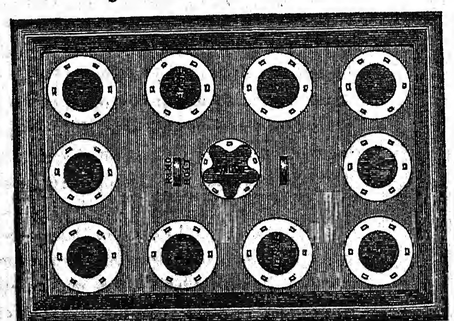


Fig. 4.—Inside Plan of the Top.



end, there were iron rings, to one of which a guy-rope was attached, for the purpose of preventing the bell from turning round, which it otherwise very frequently would, and thereby entangle the fall, so that the bell could neither be raised nor lowered. An attentive man had always charge of the guy-rope. In the inside of the bell, at each end, were moveable seats, fitted into iron ledges, cast with the bell; and at the bottom, across the centre, was a foot-board similarly secured, to place the feet on; there was also a wooden shelf on one side near the top for small tools, &c., &c., to the front of which were a row of hooks to hang the setting bars, chains, &c. Two large eye-bolts were screwed into the top of the diving bell, to which the heavy lime

and granite stones were slung by chains and raised with it, in order to lay them in their proper places. The inside of the bell was frequently whitewashed.

No. 2 bell was very similar to No. 1, but a few inches smaller.

No. 3 bell was a little larger than either No. 1 or No. 2, cast in five separate pieces and riveted together. It was 5 feet 6 inches high, 7 feet 2 inches long, and 5 feet wide outside: this bell in other respects was exactly the same as No. 1 and No. 2; it weighed 6 tons.

No. 4 was a small circular bell, in shape like a common church-bell; it was 5 feet 3 inches high, 5 feet in diameter at the bottom, and 2 feet 9 inches at the top on the outside. Across the centre, at the bottom, was placed a board upon which the workmen sat, so that, when ascending or descending, their legs were partly in the water. This bell was made of wrought iron, in plates 3 feet 3 inches long by 2 feet 8 inches wide, riveted together in the same manner as the boiler of a steam engine. The plates were $\frac{3}{8}$ths of an inch thick. This was a very inconvenient bell, from its shape, and was only used in excavating.

N. B. The annexed plans, sections, and elevations of No. 1 diving bell will afford any further information that may be required respecting its construction. The diving bells, when not in use, were always hove up above high water, and secured to the carriage by four hooks and chains.

Air-Pump, figs. 5 and 6.—The air-pumps for the purpose of supplying Nos. 1, 2, and 3 bells were double ones; that attached to No. 4 was a single one; the cylinders were brass, 1 foot high, $\frac{1}{2}$ inch thick, and 8 inches in diameter inside. The air was forced from the cylinders into a receiver, across the bottom of which was a double

Fig. 5.—Plan of Air-pump.

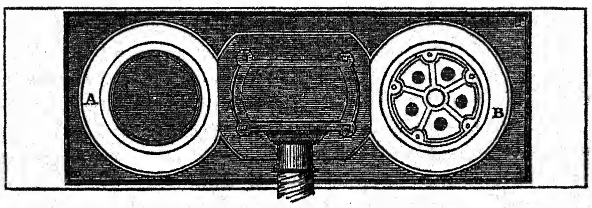
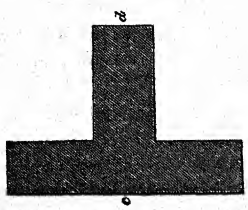


Fig. 6.—Section.



valve fixed on a piece of iron, called a saddle: this valve rose and fell as the air was either forced from the right or left hand cylinder, and was required to prevent the air from entering the opposite cylinder instead of into the hose, one end of which was screwed into the front of the receiver, and the other into the top of the diving bell. The double air-pump required from four to six men to work it, according to the depth of water the bell was working in, the nature of the work, or the number of persons in it.

Fig. 7.—Elevation of Air-pump.

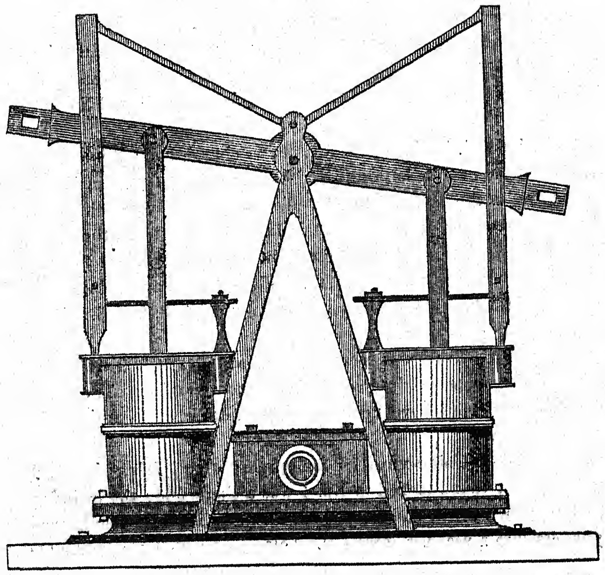
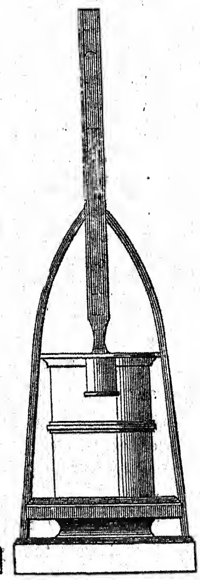


Fig. 8.—Side Elevation of Air-pump.



In these sketches of the air-pump the part left unshaded is brass.

Hose.—The hoses were made of cow-hide double,* nearly a quarter of an inch thick, between which there was a layer of coarse duck, well rubbed over with currier's dubbing; the leather was tongued at the seam, the edges thinned, turned down, and stitched through the whole. The hoses were made in lengths of about 18 feet, which were joined together by a brass male and female screw; they required to be well greased every two or three weeks with a mixture of tallow and bees'-wax; in cold weather, the quantity of the latter article was very small, but in summer more was required, to give solidity to the composition. The diameter of the hose was about 2½ inches: if well made and taken care of, one would last five or six years.

The hoses when in use ought to be supported at the joints by small lines, in order to prevent their being strained.—*See* elevation of diving bell and machinery.—Plate I.

Crab, &c. (Plate II.)—Each bell was suspended from a cast-iron crab, mounted upon a small wooden carriage, having four cast-iron wheels attached to it; over the two front ones, small pinion-wheels were placed, which were turned by a short iron bar being inserted into holes made into them for that purpose: by this means the bell was moved with the greatest facility from the front to the back of the wall. The wheels of the crab-carriage moved on a rail-road fixed on the top of a large carriage upon which they were placed. One end of the bell-fall was fastened to the frame of the crab-carriages, and the other to the barrel of the crab, passing through a double block at the top and a treble one at the bottom. The lower block was secured to

* Gutta percha is now the suitable material.—*Editors.*

the diving bell by strong chains, which were run through three strong iron shackles, one of which was bolted to the lower block, and the other two to each end of the longitudinal rib on the top of the bell. The fall was a 7-inch shroud-layed rope in six parts. Two men were sufficient to raise or lower the bell when it was under water, but it required six or eight to raise it when out or coming out. A crab and carriage, similar to the one to which the bell was attached, was used for lowering down the large blocks of granite and limestone.

Stage.—The stage from which the diving bells were worked embraced the whole *width* of the pier-wall, erected with piles from 60 to 75 feet long, and from 14 to 15 inches square: they were pointed and shod with iron at the bottom, and had also large flat stones bolted to them, by which means they were more easily fixed in their proper places. The outer and inner rows were 23 feet 6 inches apart in the clear at the top. The piles battered about ⅛th, and were placed from 10 to 12 feet from each other. The string-pieces upon which the rail-road was laid were about 40 feet long (each length) and from 14 to 15 inches square, secured to the piles by screw-bolts and nuts. The string-pieces were supported by strong cleats under them, which were nailed and screwed to the piles; they were also further secured by an iron band. The level of the rail-road on the stage was 9 feet 6 inches above high-water spring tides. A gang-board, 15 inches wide, was fixed on the outside of the string-pieces, for the workmen to walk on. Strong struts were fixed against the outer and inner rows of piles, and the stage was secured to the shore by iron chains, which could be tightened by screws when required. The front and back parts of the stage were connected together by cross-pieces of timber (14 inches × 7 inches), bolted down to the string-pieces; underneath them cleats were nailed, for the purpose of steadying the stage, and keeping it apart: these cross-pieces were occasionally shifted: one was always placed at each end of the part of the work where the diving bell was employed, a space generally of from 30 to 40 feet in length. At different parts, along the stage, sheds were erected, in which the air-pumps were placed, and also a small windlass, by which the box containing the rock and shingle that had been excavated by the workmen employed in the diving bell was drawn up, and the contents emptied into a barge stationed to receive it. By similar means spalls and mortar were lowered down to the masons who were building in the bell. A boat was always in attendance, in which there was a supply of mortar and small stones, &c. kept in readiness, and also a labourer to empty and fill these boxes. A small line was attached to them, by which means they were pulled into the bells by the workmen. The floors of the pump-houses were about 6 feet above high water, and as the tops of them abutted against the string-piece of the stage, and were level with it, their roofs were found very useful for laying on them many small articles required by the workmen employed on the stage: the mortar-box had a cover to it. The roads by which the large stones were brought from the shore to the stage were formed by two baulks about 14 inches square, laid parallel to each other, 3 feet apart, having a gentle slope towards the front wall of the pier, by which means the truck upon which the stone was placed was easily pushed forward by one man, as a rail-road was laid upon the baulks: one end of them rested upon a strong piece of timber, which was spiked to two of the inner row of stage piles, and the other end on the bank on the shore: the centre was supported by uprights. These roads were from 60 to 80 feet long: a piece of wood was nailed across the outer end of them, to prevent the truck from running over.

Bell Vessel.—The diving bells at Hobbs' Point were at first worked from a schooner of about 120 tons: a stage having been erected across her deck, projecting over each side, from thence the bells were suspended from crabs placed on the stage.

The air-pumps were fixed on the deck of the vessel. This mode of working the bells was attended with many inconveniences, particularly from the great rise and fall of the tide, by which the diving bells could not, without much difficulty and constant attention, be kept working in the same place; therefore, after clearing in a rough manner the general outline required for the area of the pier-walls, this method of working the bells was discontinued, and the stage already described was erected.

Dredging Boat.—The greatest part of the mud and a large quantity of small shingle were removed by a dredge, worked from a flat-bottomed barge, 48 feet long, 13 feet wide, and 3 feet deep; across the gunwale a platform of 3-inch plank was laid, and on it a cast-iron crab was fixed, near which a small derrick was raised 7 or 8 feet high. The pole to the end of which the dredge was attached was 37 feet long: when it was lowered for the purpose of scraping up the mud, shingle, &c., the pole was placed alongside the barge, the top inclining forward, and secured to the gunwale by a rope halter fastened to a ring-bolt fixed on the inside of the vessel. A small chain was fixed to the front of the dredge, which ran through a block fastened to the top of the derrick, from thence communicating with the crab, by which the dredge was drawn along the bottom, and raised out of the water, and then emptied (by means of a rope attached to it with a hook) into the barge. Four men were required to work the dredging vessel, viz. two at the crab, one at the dredge to keep it in its proper position, and one to empty it, and level the rubbish, &c. in the bottom of the barge.

Tin Tubes and Borers used in Blasting Rock under Water.—The pitching borer, so called from its being the first used, was a round iron bar, 2¼ inches in diameter, and about 2 feet long; with this tool a hole was bored about 6 or 8 inches deep; a smaller borer of 2 inches in diameter was then used to bore it to the depth required, which was sometimes 4 or 5 feet. The powder to charge the mine was put into a cylindrical tin case, generally from 10 inches to 1 foot long, but varying in length according to the quantity of powder required. A small tin tube half an inch in diameter (outside) was inserted, and soldered into the case holding the powder, about 6 inches down the inside of it; the top of the case was covered with a piece of tin, through which the small tube was put. Great care must be taken that both the tube and case are well soldered, that the powder should not get wet. The tin tubes were made in lengths about 4 feet 6 inches each, the tops of them splayed a little (like a funnel), the diameter of which was 1½ inch; into it the next length of tube was inserted, being carefully puttied round to keep out the water: a sufficient number were used, so that the last should rise a little above the surface of the water. The mine was fired by dropping a small piece of red-hot iron (which was pointed at the end) down the tube.

Description of the Tools used in the Diving Bell.—The tools used by the masons employed in the bell building were —

Two setting bars, the lower ends of which were curved up, which enabled the workmen to move the large stones with greater facility than they otherwise could, in the confined space they worked in.

A spall-driver, the handle of which was 3 feet long, of 1¼ inch diameter rod-iron, with a head at the end of it 3½ inches wide: the use of the tool was to drive down the small pieces of stone between the joints of the large ones, which, from the depth of water, could not be so well done by a common mason's hammer.

A sledge hammer, or maul.

A narrow plate of iron, about 1½ inch wide, $\frac{1}{10}$th thick, and 2 feet 9 inches long, with a handle: this was used to work the mortar in between the vertical joints.

A short boat-hook, about 4 feet long.

A shovel with a short handle.

Two signal hammers.

A pair of lewises.

Two chains, a large and a small one, a swab, a piece of chalk, a trowel, and foot rule.

The miners in the bell employed in excavating shingle, rubble, and rock, required the following tools, viz.:

A crow-bar, 3 feet long.

A miner's pick with a short handle.

A shovel.

A sledge hammer.

Two signal hammers.

Several gads of different lengths and sizes, a swab, and a piece of chalk. Tin tubes, powder, and borers, were taken down by the workmen when wanted.

Manner of working the Diving Bells.—The bells were at first, for a few months, worked from a vessel of about 120 tons, but from its being found very inconvenient, a stage (as before described) was erected; on the top of which was a strong wooden carriage, mounted on four iron wheels, traversing on a rail-road from one end of the stage to the other (which extended the whole length of the front wall of the pier, 200 feet); on this carriage another rail-road was laid, on which was placed a crab and carriage, and to it the diving bell was attached: by this means it could be moved wherever required, with the greatest ease. In the summer, the bells were employed from 5 o'clock in the morning till 7 o'clock in the evening; the remainder of the year, from daylight till dark. The principal directions necessary to be given for carrying on the work in the bells were communicated by the men employed in them to the superintending foreman (who was constantly stationed on the stage), by striking the side of the diving bell with the signal hammer a certain number of strokes, each having a particular signification, of which the following is an explanation, viz.:

One stroke, signifies that they require more air.			
Two strokes, to let the bell remain as it is.			
Three	„	to raise it.	
Four	„	to lower it.	
Five	„	to move the bell to the front of the wall.	
Six	„	„	to the back.
Seven	„	„	to the right.
Eight	„	„	to the left.

All other communications were made by writing them with chalk on a small board painted black, to which a line was attached, reaching from the bell to the stage, which was pulled up by the workmen when they wished to send up a message: there was a small chain, about 5 or 6 feet long, fixed to the lower end of this line, or otherwise it would soon have worn out by rubbing against the bottom edge of the diving bell when drawing the message board up and down.

A carriage and crab similar to those used for the bell was employed for lowering the large stones to the workmen, and the small stones and mortar were sent down to them in a small box. A labourer was stationed in a barge, who attended upon two bells, either to receive what the miners excavated, or to supply the masons with materials.

The following was the distribution of the men attached to each bell, having a foreman to superintend the whole of them:

Description of Workmen.	The Number of the Diving Bell and how employed.						Occupation of the Workmen.
	Nos. 1 and 2.—Building.			Nos. 3 and 4.—Excavating.			
	For No. 1.	For No. 2.	Remarks.	For No. 3.	For No. 4.	Remarks.	
Masons	1	1	. . . . .	2	2	Labourers	Employed in the bell.
	1	1	For a relief	. . .	. . .	. . . . .	Above, selecting stones.
Labourers	1	1	. . . . .	1	1	. . . . .	Attending guy-rope.
	2	2	. . . . .	2	2	For a relief	At the crab.
	5	5	. . . . .	4	4	. . . . .	Working the air-pump.
	. . 1 . .		. . . . .	. . 1 . .		. . . . .	In the boat attending.
Total Workmen	21 for two building bells			and 19 for the two excavating.			

One foreman superintended the four bells; when more hands were required to work the air-pump, one of the men stationed at the crab assisted.

The masons attached to the diving bells, when not down in them at work, were employed on shore in preparing and selecting such stones as were required, and the labourers were stationed either at the crab or guy-rope. At high water, five or six men were necessary to work the air-pump, one only being then left at the crab. The foreman had the entire direction and distribution of all the workmen attending the diving bells; no man was allowed, upon any occasion whatever, to leave his post without his permission. His particular duty was also to pay the greatest attention to all signals. At low tide, if the bells were not in deep water, two or three men were quite sufficient to work the air-pump. The workmen employed with the diving bell were not allowed any regular hour for breakfast or dinner, but took their meals by turns, at whatever time they could best be spared for a short period from their work. In the summer, the men working at the bells were relieved three times during the day, viz. the first party went down at 5 o'clock in the morning, the second relieved the first at 10, and the first relieved the second at 2, and *they* remained down till 7 in the evening, at which hour they left work: by this arrangement one party went down in the bell twice one day, and once the next, alternately: in the winter, on account of the shortness of the days, the men employed in the diving bells were only relieved once, viz. at 12 o'clock: the average time, therefore, that the workmen were down in the bells was about 4½ hours, both in summer and winter, each spell. The reason an additional man was allowed to work the air-pump attached to the building bell was, because it was moved about oftener, and also required to be kept more free from water.

The following were the rates of pay the workmen received who were employed in the diving bells at Milford Haven:

	Masons.		Miners.		Labourers.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*
Pay per hour when down working in the bell	0	8	0	7	0	6
Pay per hour when relieved and employed above	0	3	0	2	0	2
Daily pay during summer, working fourteen hours per diem, viz. seven hours in the diving bell, and seven hours above	6	5	5	3	4	8
Daily pay during winter, working eight hours per diem, viz. four hours in the diving bell, and four hours above	3	8	3	0	2	8

The foreman in charge of the bells had £1. 5*s.* per week constant pay, both winter and summer.

The labourers employed at the air-pump received 2*d.* an hour during summer, and 1*s.* 8*d.* per diem during winter; they never worked in the diving bell. The common wages at Pembroke were 2*s.* 6*d.* per diem for artificers, and 1*s.* 8*d.* for labourers.

General Observations on Bell-work.—From the improvements made in the construction of diving bells, and the facility with which the workmen can be furnished with an ample supply of air by the air-pump, any description of work may now be executed by their means, and with very little difficulty or danger. Having for the space of four years been constantly in the habit of going down in the diving bells employed in the erection of the landing wharf at Hobbs' Point, Milford Haven, for the purpose of inspecting and measuring the work in progress, I am fully satisfied that building may be performed under water with an equal certainty as above; but the greatest possible care must be constantly paid in carrying on the work; to insure which, it is essentially necessary that a very steady attentive man should have the entire direction of all the people attached to the diving bells, who will also pay the strictest attention to all signals made by the workmen employed down in them, and by whom the whole of the machinery, gear, &c., (*particularly the fall,*) should carefully be examined every morning, and a written report given that he had done so to the Officer superintending the work. The greatest inconvenience experienced by the men working in the bells was the pain produced in the ears from the pressure of the condensed air on the drum, which occasionally, when in very deep water, brought blood from them, and also from the nose: this, however, rarely happened, and as a proof that they did not suffer any very great inconvenience, *one* man only ever quitted bell-work from choice, and several were employed in them from the commencement to the completion of the work, a period of upwards of four years. The workmen in the diving bells always wore thick flannel frocks and breeches, and high mud-boots well greased, and most of them flannel or worsted caps. From the depth of water at high tide (especially during the winter months), and from the heavy rains, it was so muddy that candles were obliged then almost constantly to be used, when it was found necessary to have an additional man at the air-pump. From the greatest attention to the signals made by the workmen employed in the diving bells, and a constant examination of the machinery and gear, not the most *trifling accident* occurred during the whole period the bells were in use; but I feel it my duty to state (as a warning), that a most serious one would most probably once have happened, had the bell not been in very deep water at the time, in consequence of the small line attached to the message board getting between the cheeks and sheave of the lower block, and thereby for a short time jamming the fall, and as the bell was lowering down, several yards of it became slack; therefore, when the line got disengaged from the block, which it soon did, the diving bell suddenly fell at

least 10 feet: the jerk thereby occasioned was not felt much, as the bell most fortunately was then in very deep water, otherwise it would most probably have broken the fall, and proved fatal to the two men that were in the diving bell. To prevent the possibility of this happening again, I immediately had three straps of leather, about 2 inches wide, nailed across the cheeks of all the lower blocks, which I recommend always being done.

W. J. S.

As Officers may be often thrown into situations where, although advisable to use a diving bell, it may be impossible to procure a cast-iron bell of sufficient dimensions, the following account of a wooden bell, extracted from the 'Transactions of the Institution of Civil Engineers,' may perhaps prove useful.

DESCRIPTION OF A WOODEN DIVING BELL EMPLOYED BY MR. RENDEL IN THE CONSTRUCTION OF THE LARY BRIDGE, NEAR PLYMOUTH.

The internal dimensions of the bell were 5 feet 6 inches in length, 4 feet 6 inches in width, and 5 feet in height: the sides, ends, and top were made of two thicknesses of 1½-inch well-seasoned elm board; the inner case was constructed with its joints parallel to the top and bottom, or mouth of the bell, whilst those of the outer case were vertical, or at right angles to the inner joints; the top joints were crossed in the same manner as the sides; all the joints had a slip of flannel saturated in a composition of bees'-wax laid between them, and were dove-tailed together, and set as close as possible by means of screw-clamps, &c.: the sides were rabbeted to the end, and the internal angles strengthened with brackets. The whole surface between the inner and outer case was covered with double flannel, saturated as just described, and was then connected together by a number of wooden pins dipped in tar, and tightly driven: the top was perforated with six holes, of 6 inches diameter each, in which were firmly fixed a corresponding number of strong lenses set in white-lead; a hole of 3 inches diameter was made in the centre, in which was fixed a brass pipe with a screw to attach the air-tube: four hoops of wrought iron, two internal and two external, were screw-bolted together, through the sides and ends of the bell; internal and external cross-lacings were also screw-bolted to those hoops, and to the sides and top of the bell; in these lacings, the chains by which the bell was suspended were fixed in strong iron eyes, which passed through the top of the bell, and were riveted to the inner lacings. All the screw-bolts were driven with tarred oakum, and every precaution was taken to render the whole air-tight. The bell, thus finished, weighed about 30 cwt., but it required from 5 to 6½ tons to sink it, and overhaul the ropes by which it was suspended: cast-iron plates, from 1¾ inch to 2 inches in thickness, were therefore hung externally round its sides and ends, till it was sufficiently loaded to sink with steadiness in about 25 feet water. The bell was provided with two moveable seats and a foot-board for the divers, and at top long boxes were fixed, in which their tools were kept; it was provided with air by a double-acting force-pump, the cylinders of which were 7 inches diameter in the clear, making a 14-inch stroke. This pump was generally worked by four men, and made on an average, according to the depth of the water and run of the tide, about eight double strokes in a minute.

This bell was mounted and worked upon a carriage and platform similar to that described by Lieut.-Colonel Savage.

W. DENISON, R. E.

DIVING DRESS AND APPARATUS.*

For the removal of wrecks, shoals, enlarging entrances to harbours,† making submarine surveys, &c., where so much of the diver's success depends upon his being able to extend his operations over a large space of ground, the Diving Dress possesses many advantages over the Diving Bell, as the latter, although very useful in building under water, affords so limited a space for working that it much impedes the operations of a diver when employed on either of the above-named objects. Thus, for general purposes, the diving dress is preferred to the bell, and it has been a desideratum to ascertain the best form to be given to it, so as to preserve the health, and endanger as little as possible the safety, of the men employed.

Mr. Deane appears to have been the first person known to have used the diving dress, or at least to have turned it to any practical utility. His apparatus is exceedingly simple, and is usually styled the 'Open Dress,' on account of the metal helmet (which covers the head and breast of the diver) being separate and unattached to the lower part or body of the dress. The latter is made of stout Macintosh cloth, and forms a complete water-proof covering to the body from the feet to the neck: here, as well as at the ends of the sleeves, there are openings left sufficiently large for drawing the dress over the person, and for passing the hands through, which must be left exposed to enable the diver to work properly: these ends are tightened round the wrists by linen wrappers, while the upper opening is plaited, and loosely drawn in round the neck, and confined there by a handkerchief or band. The metal helmet, with a loose canvas jacket attached, drops down over the head upon the diver's shoulders, being prevented from coming off by weights suspended from it, resting against his breast and back. The helmet on this principle becomes a small portable diving bell carried about by the diver while at the bottom, and the circumambient water is at the same time prevented, by the dress, from getting to his person. An air-pipe leads from the back of the helmet to the surface, and when a proper supply of air is delivered from the air-pump above, the water will be perfectly excluded from the helmet down to about the level of the neck: the collar of the dress should come up as high as the diver's ears, so that any water accidentally rising higher, from air imperfectly supplied or other causes, may be prevented, as much as possible, from flowing over the collar and wetting his person,—a circumstance attended with most injurious effects to health, and necessarily retarding the operations. It should be remarked, that with Mr. Deane's apparatus the diver must always keep his head as nearly as possible upright; in stooping or lying down with the head out of that position, the water will have a tendency to rise in the helmet and flow over the collar; and if by accident he should fall down head foremost, or become entangled with the head downwards, he would certainly be drowned, unless speedily extricated and hauled up. This is a great inconvenience, as most divers prefer the stooping or creeping posture while working to any other, and it becomes troublesome and painful to keep the head erect while the rest of the body is not so. On the other hand, divers remark that the air they breathe is much purer while working in this dress than in what is called the 'Tight or Close Dress,' which will presently be described, on account of the freedom with which the waste or foul air can escape from a helmet open at the bottom.

The inconvenience, and even danger, attending the use of the open dress, which is

* By the late Capt. Hutchinson, R. E.

† Helmet divers were regularly employed in enlarging the entrance to St. George's harbour, Bermuda.

particularly felt by inexperienced divers, has led to several modifications being made in it by ingenious men, with the view of connecting the helmet and lower part of the dress so as to form one complete water-tight covering which shall enable the diver to work in any position without being subject to the risk and inconvenience of water entering from without: among these may be mentioned Messrs. Bethell, Fraser, Sadler, and particularly Mr. Siebe, of Denmark Street, Soho, whose pattern is perhaps the most perfect yet produced. Mr. Siebe, by the recommendation of Lieut.-General Sir C. Pasley, was employed by the Admiralty in making the greater part of the dresses and apparatus required for the removal of the wreck of the *Royal George* at Spithead, and he has also supplied those required for their Naval Establishments, vessels of war, &c. His improved construction on the water-tight principle will now be described.

The dress represented in Plate I. fig. 1, may be considered as divided into two parts. The helmet or upper part (unyielding) is formed of metal, copper tinned over, and covers the head and breast; the lower part (flexible and yielding) covering the legs, body, and arms, is formed of Macintosh cloth, with sheet India-rubber outside, which is found to preserve it from rotting and to keep the dress much drier than when the cloth is exposed: a leather band, fixed round the top of the lower part and pierced with twelve holes at equal distances from each other, fits on to the lower edge of the helmet, where there are twelve projecting brass screws, so placed as to fit into the holes in the band; they are screwed together with thumb-screws. The joint is made water-tight by the leather band and by a species of thin leather washer fixed round the lower edge of the helmet: as in the common diving dress, there is an internal collar coming up to the diver's ears, and tied round the neck with a handkerchief, so that, should any small quantity of water penetrate at this joint, which will occasionally work in through the screw-holes, it will be collected in the cavity between the collar and helmet, and may be shaken out by the diver on his ascending and having his helmet taken off.

Plate I. figs. 3, 4. The fresh air is forced in by a pipe screwed on to the back of the helmet, and the foul or waste air escapes by an aperture near it, covered by a valve which is so constructed as to be kept open by the force of the waste air rushing out so long as it is superior to the pressure of the surrounding water; but if it ceases to be so, the valve closes by the pressure of an elastic wire spring which has been previously collapsed by the pressure from within, and thus the water is always excluded. The fresh air in Mr. Siebe's plan is not suffered to enter the helmet at one internal orifice, but is divided after leaving the air-pipe into three or four branches, formed in the helmet so as not to throw too strong a stream of air upon the diver's head. Other makers prefer having a single orifice for the entrance of the fresh air, situated immediately above the centre lens or glass of the helmet, with the idea of dispersing the vapour which has a tendency to collect upon the inside of the glass and to render it dim. The helmet has three glasses or lenses, the two side ones oval, the centre circular,—which is made to unscrew, so that if the diver should find it necessary to come up for fresh air or to communicate anything for which he finds his signals insufficient, he may merely have this centre glass removed and replaced after making his communication.

Mr. Siebe has contrived an ingenious arrangement by which the diver may be relieved of the pressure of his weights and helmet in about half a minute after he has come up from the bottom; so that if he has slung some heavy mass below, either a gun or a large piece of timber, in working against a wreck, or wishes to be relieved from their weight from a feeling of fatigue, it may be done without the necessity of
Plate I. figs. 5, 6. unscrewing the whole dress. This arrangement is effected by making the upper part or head of the helmet to screw on and off the lower part or gorget. The lower part

of the head and upper part of the gorget being circles of 9 inches diameter, their circumferences on the interior of the one and exterior of the other are divided into eight equal parts; every alternate division is cut with a screw, the intermediate ones being left with a smooth surface: thus the head of the helmet being dropped upon the gorget in such a position that the divisions cut with screws of the former may be in contact with the plain surfaces of the latter, on turning the helmet the ⅛th part of the circle, that is, about 3½ inches, both the surfaces with screws will fit into each other and fix the two parts closely together, a leather collar between making the whole water-tight. In this manner, with the centre lens to unscrew for the mere purpose of giving the diver air or an opportunity of explaining anything, and with the upper part of the helmet to take off to relieve him of its weight if he should have to remain above water for any length of time before making another descent, the helmet is as complete and serviceable as can be desired.

Plate I. figs. 1, 2. Two brass eyes are fixed, one on each side of the lower circle of the head of the helmet, through which are passed the cords for hanging lead weights (about 40 lbs. each), one of which is suspended at the diver's back, the other in front of his breast: the head of the helmet is thus additionally secured and pressed down upon the gorget.

As the diver's hands must be exposed, to enable him to work properly at the bottom, where he has generally to feel his way from the water being too thick and obscure to allow him to distinguish surrounding objects, the openings left at the ends of the sleeves must be very carefully closed over the wrists by plaiting those ends and passing linen wrappers tightly round,—soft bandages having previously been placed underneath to prevent the skin from chafing: this must be carefully attended to, otherwise the water would be sure to penetrate: the pressure will cause at first slight pain and numbness in the hands, but the sensation will go off on getting into the water.

To guard against the effects of damp and cold striking through the dress, the diver must be well clothed in flannel or woollen dresses: he generally puts on two suits, each consisting of a pair of drawers, stockings, and a Guernsey frock: these must be well dried, and aired on being taken off: a constant change is necessary, so that every diver should have about six suits in wear. At Spithead the regulations as to drying were strictly enforced; a cabin was set apart in the vessel on board of which the men were quartered, as a drying-room, with a stove in the centre and rails all round for hanging the dresses on; the divers' attendants received them as they were taken off, took them to the drying-room, and supplied fresh ones before the ensuing tide: in this way the divers were always provided with warm comfortable garments, but notwithstanding these precautions many were subject to violent attacks of rheumatism.

Every diver should likewise be provided with three good serviceable waterproof dresses to be worn in turns, so that he may be enabled to change them continually, if required: the dresses not in use may be kept exposed to a *gentle* heat, so as to dry them thoroughly, but they should on no account be hung up to dry in a *hot* sun, as the India-rubber would thereby be melted.

The diver's feet are protected by heavy shoes with lead soles, weighing about 24 lbs.; these, together with a pair of woollen stockings, are worn over the dress; the stockings being first drawn on, prevent the shoes from cutting it. The feet of the dress should be soled with leather over the India-rubber, to prevent its being cut by small gravel working in over the shoes. The dress is also protected from rubbing or chafing by a canvas jacket and trousers worn over so as entirely to cover it.

In descending to a wreck, the diver goes down a rope ladder, which is made fast

to the deck of the vessel above, and weighted by a 3-cwt. pig of ballast below: the rungs should be about 18 inches long from end to end, or 15 inches between the sides, which are formed of 2½-inch rope; they should be 15 inches apart under water, and above water this space should diminish to a foot, as the great weight of the dress and appendages will make it laborious for the diver to step higher when he is not buoyed up by the water. A breast or life line completes the diver's equipment: it should be either patent netted line or 2-inch rope, laid what is technically called the 'reverse way,' so that it may not have a tendency to twist when under water, which should be avoided as much as possible.

This line is passed round the body under the arms, then leads through a knot in front of the breast to the surface, where a careful man has charge of it, whose duty it is to attend to all signals made by the diver, consisting of a certain number of pulls on it for any communication he may wish to make, which he generally arranges with his assistant before going down: these signals are very simple, and have generally reference to the working of the crabs or capstans, while the diver is slinging anything below: thus, 1 pull signifies 'Heave round,'—2 pulls, 'Hold on,'—3 pulls, 'Lower the large rope,' (called by divers 'bull rope,')—4 pulls, 'Lower a second rope;' a number of pulls signify that the diver wishes to come up, &c., &c. While the diver is at the bottom, another careful man is stationed at the air-pipe, which leads from the back of the helmet round under the left arm to the front, and then to the surface; he attends to any signals that may be made on it for more or less air, and sees that it is carefully coiled up as the diver ascends. Neither the pipe nor line should ever be allowed to become slack, but a gentle strain should be kept on each.

OF THE AIR-PUMPS.

Plates III. IV. The best kind of diving air-pumps used for helmet divers, when working in depths not exceeding 13 to 15 fathoms, are composed of three brass cylinders, 9 inches high and 4 inches interior diameter, with pistons giving a 7-inch stroke, attached to a horizontal axle with three cranks forming angles of 120° with each other: the axle is worked by two handles at the ends, with two men to each: the air is thrown from each cylinder in succession on the downward strokes of the pistons into a common barrel or reservoir below the cylinders, thence into the air-pipe, which is screwed on to one end of it. There are valves to the pistons and cylinders, which are depressed on each downward stroke of the former, and allow the air to enter the barrel; they close again with considerable force on the pistons being raised, and prevent the air from returning. Fresh air is admitted from the exterior by small circular orifices left above the pistons and immediately below their rods; thus there is a constant unintermitting stream of air forced down to the diver, which, by the old plan of a single barrel and piston worked by levers, was not the case, as on the rise of the piston the current was interrupted until its next descent.

This plan of having three cylinders has been generally adopted by most makers, but until the year 1840 it had one essential defect, which was caused by the air becoming heated by the friction of the pistons within the cylinders; it was thus sent down to the diver hot and impure; constant repairs were required, and a pump of larger dimensions than necessary had to be used: to remedy this defect, Mr. Siebe introduced an important improvement in his air-pumps by enclosing the cylinders in a cold water cistern; this is continually filled by a suction-pump drawing up water from the sea, or wherever the operations may be going on, its piston being worked at the same time as those of the air-pump, by means of an eccentric circle attached to

the common axle and revolving with it: a waste-pipe leads the water away after it has reached a certain level; thus there is a constant stream of cold water around the cylinders, which has the desired effect of keeping them perfectly cool and of sending down pure and cool air to the diver. The whole detail of construction and workmanship of Mr. Siebe's pumps is very perfect, and they seldom or ever fail, excepting from some trifling cause which may readily be rectified. At a depth of 90 feet under water, the diver has to sustain a pressure of about three atmospheres, which must be counteracted and the equilibrium preserved by throwing air of corresponding density into the helmet. An air-pump of the above dimensions will not be more than sufficiently powerful to keep up a steady supply of air thus condensed during the whole time the diver is at the bottom, where he sometimes remains from two to three hours. As the operation of pumping at this depth for so long a time becomes very laborious, it is necessary to have two, or even three, reliefs of men at the pumps to change about every ten minutes: those not actually pumping will be available for the other duties of working the crabs and capstans, attending to the gear, &c. At Spithead we found that two and a half reliefs, or ten men at each pump, was the minimum that could be employed; thus each diver will require at least twelve men, including his two assistants, and fifteen should be allowed, so as to give some spare men for boats and other duties, for which on such operations they will always be required.

The air-pump is fixed into a box measuring 2 feet square and standing 3′ 6″ high, so that there may be a height of 3 feet to the centre of the handles, which is the best height for working them: the box has a lid to close it, but this should never be shut down, if it can be avoided, while the air-pump is being worked, as the air will then be too much confined: there is a fly-wheel on the axle, 3 feet in diameter.

In the Levant, diving has been carried on in far greater depths than any which have been attempted in England. During a naval engagement at Tchesme, near the island of Scio, between the Turks and Russians, about seventy-five years ago, the Turkish and Russian flag-ships were both sunk, and, it was supposed, with a considerable quantity of treasure on board: many attempts were made to recover it, and the depth being 30 fathoms, the enterprise was attended with much difficulty and some danger: a pump for such an operation is required to be much more powerful than the one already described, and it will be more economical to work it by a small steam engine fixed on the deck of the vessel above, than in any other way. The one used for the operations* in the Levant contained three cylinders 5¼ inches diameter, with pistons giving a 32-inch stroke. The axle made twenty-two revolutions per minute, and was worked by a steam engine of 10-horse power. With these powerful machines the diving was performed in comparative safety, but I have been informed that the divers had to be relieved every half hour, that they were then apparently unconscious of the time that had elapsed, and while below had lost all recollection of everything excepting the object for which they were sent down. I do not find, however, that they have been permanently injured by so perilous an occupation, but are generally stout, robust men, whose frames are probably peculiarly constituted to enable them to resist the effects of protracted submersion at such great depths.

* These operations were conducted by Mr. Love, a very able submarine Engineer, who was employed at Gibraltar in getting up a portion of the American frigate *Missouri*, burned in that bay in the year 1843.

OF THE AIR-PIPES.

The air-pipes are usually formed of an outer casing of solid sheet India-rubber, about $\frac{1}{2}$ inch thick, stiffened internally with spiral wire, the bore or opening for air being left about $\frac{1}{2}$ inch diameter in the clear: thus the total diameter of the pipe on the outside will be from $1\frac{1}{2}$ inch to $1\frac{3}{4}$ inch; it must be entirely covered with canvas to protect the India-rubber from friction in descending to the bottom; the part remaining above water should be carefully coiled away in a tub, and any portion which may have to lie along the deck of the vessel or on the ground should also be covered by lengths of wooden trough, about $2\frac{1}{2}$ inches or 3 inches square, to prevent the workmen from treading on it. Too many precautions cannot be taken to keep the air-pipe from being injured, as upon this the safety of the diver in a great measure depends. The wire used for stiffening it should be of copper or gun-metal. Pipes of inferior manufacture are sometimes stiffened with iron wire tinned over, but these should be rejected as unfit for use, for the moisture will cause the wire to rust, which will then soon become broken, and by degrees cut through the India-rubber: a fracture may thus be caused in the pipe, which would be attended with serious consequences to the diver, if it occurred while he was at the bottom; for as in such a case the air thrown into the pipe would escape before it reached him, the equilibrium of pressure would be destroyed, and the surrounding water would act upon his person with a pressure due to the depth at which he might happen to be working, or, at a depth of 90 feet, to three atmospheres.

Some instances of this have actually occurred where the body has been as it were so squeezed and compressed by the weight of water, that the blood has been forcibly driven into the vessels of the head and neck, causing a state resembling asphyxia, and disabling the diver for a month or six weeks: fortunately none of these cases, though very alarming, have terminated fatally.* To guard against such frightful accidents, every diving apparatus should be provided with a safety-valve opening downwards, to be screwed on between the end of the pipe and the helmet. The air on being forced in from the pump opens the valve and allows it to pass into the dress; but on this pressure being removed, the valve closes and prevents any of the air already in the dress from escaping back through the pipe, and the quantity of air thus enclosed within the dress would be quite sufficient to support life for several minutes, or for a much longer time than would be required to haul a man up from the bottom.

The air-pipes are made in lengths of from 30 to 40 feet, with union screw-joints to each, so that they may be screwed up without twisting. They should be proved from time to time to ascertain that they are perfect throughout, by closing one end and forcing in air from the other by the air-pump to any degree of condensation that may be considered necessary, which may be ascertained by a mercurial gauge fitted to the pump.

It should be remarked that diving operations may be carried on at sea during half a gale of wind, for when about 6 feet below the surface divers feel little or nothing of the motion of the waves above them; the principal inconvenience they have to sustain is the motion of the vessel above, which sometimes prevents their signals from being properly delivered, and jerks their ladder up and down.

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* Two privates of the Royal Sappers and Miners suffered in this manner in 1841 and 1842, while employed under Lieut.-General Sir C. Pasley as divers over the wreck of the *Royal George* at Spithead. When got up on deck they were insensible; blood was running from their ears, noses, and mouth; their faces and necks were swollen and discoloured, and a perfect mass of lividity.

The following is a list of the articles composing Mr. Siebe's diving apparatus:

1. A three-throw forcing air-pump, with apparatus for keeping the cylinders cool, and gear-work in a strong wooden chest, with iron fly-wheel, wrenches, joints, &c., complete.
2. Improved diving helmet, with strong plate glasses and brass frames; the front lens to unscrew, and head to screw off; a brass collar and screws with which the dress is fastened water-tight.
3. Three patent India-rubber dresses to fit the helmet.
4. 150 feet of patent India-rubber pipe, ½-inch bore; solid sheet of India-rubber inside and outside, with brass screwed joints and two extra joints.
5. Six Guernsey frocks, 6 pairs of drawers, 6 pairs of stockings, 1 canvas jacket, 1 pair of canvas over-alls, 1 pair of shoes with lead soles.
6. Two lead weights, 1 chest for clothes, 1 basket for helmet, 1 knife with leather case and strop, 2 worsted caps, 2 handkerchiefs, and a patent life or breast line.

Price of the above, £160.

Weight of diving apparatus worn by a diver:

		lbs.
Helmet and gorget		23
Lead weights	front	43
	back	40
Shoes		24
Flannels		10½
India-rubber and canvas dress		20
Weight borne by a diver		160½

With respect to the pay of the divers,—

At Spithead the military divers of the Royal and E. I. Company's Sappers and Miners were rated in three classes, according to their skill and ability.

	s.	*d.*	
The 1st class received	2	0	per tide.
2nd "	1	9	"
3rd "	1	6	"

The number of tides per day varied from 2 to 3, and their average time of working was 2 hours.

Thus, taking one day with another, the divers would receive per day as follows:

	s.	*d.*
1st class	5	0
2nd	4	4
3rd	3	9

And where there is no tide-work, as in the Mediterranean, this would be a good rate of *daily* pay for *military* divers: civilian divers, however, would expect at least double this rate, or even more; but volunteers may always be found among soldiers, who will become sufficiently expert in the course of a few weeks.

N.B. The above rates are exclusive of their military pay or 'Subsistence.'

References to Plates.

Plate I.

Fig. 1. The diver in his dress, supposed to be at the bottom of the sea.

A. Air-pipe, screwed on to a nozzle at the back of helmet, confined by a belt round the waist, and led up under the left arm to the surface.

B. Breast or life line passed under the arms, partly concealed by W, the front weight of about 43 lbs., with a similar one at the back.

K. Knife in waist belt, used for cutting away anything with which the diver may become entangled.

L. Ladder line, to lead the diver back to his ladder after having travelled over the space allowed by its length.

P. Pricker, about 4 feet long, for probing or feeling in mud or soft ground.

S. Shoes with lead soles, weighing 12 lbs. each.

Fig. 2. Front elevation of helmet, with the upper part screwed to the lower, shewing the centre circular lens, to unscrew when required.

Fig. 3. Back elevation of ditto, shewing the nozzle for screwing the air-pipe, and the escape-valve for foul air.

Fig. 4. Section through the helmet, shewing the branches for the introduction of fresh air, the orifice for the escape of foul air, and the screw joint for connecting the upper and lower part.

Figs. 5 and 6. Plans shewing the alternate screw joint of connection.

Plate II.

Fig. 7. Side elevation of helmet.

Fig. 8. Plan of the lower part of helmet inverted, shewing the pads for the shoulders, and projecting screws.

Fig. 9. Plan of the top of the escape-valve, with the orifice for inserting the pin and cover, shewn in figs. 12 and 13.

Fig. 10. Side elevation of escape-valve, shewing the circular apertures in the cover for the escape of the foul air.

Fig. 11. Section through the seat of escape-valve, shewing the perforated cover screwed down.

Figs. 12 and 13. Shewing the section and plan of pin and cover of escape-valve, with the spiral spring of brass wire lying on the cover.

Fig. 14. Thumb-screw and plate for screwing up the lower part of the dress.

Plate III.

Figs. 1 and 2. Front and side elevations of air-pump.

a, a, a. The three piston-rods, successively raised and depressed by the revolution of the cranks, *d, d, d,* on the horizontal axle, A B. The centre piston, being raised to the top of its cylinder, shews the circular orifice, *b,* for the entrance of fresh air.

a′, a′, a′. Connecting rods.

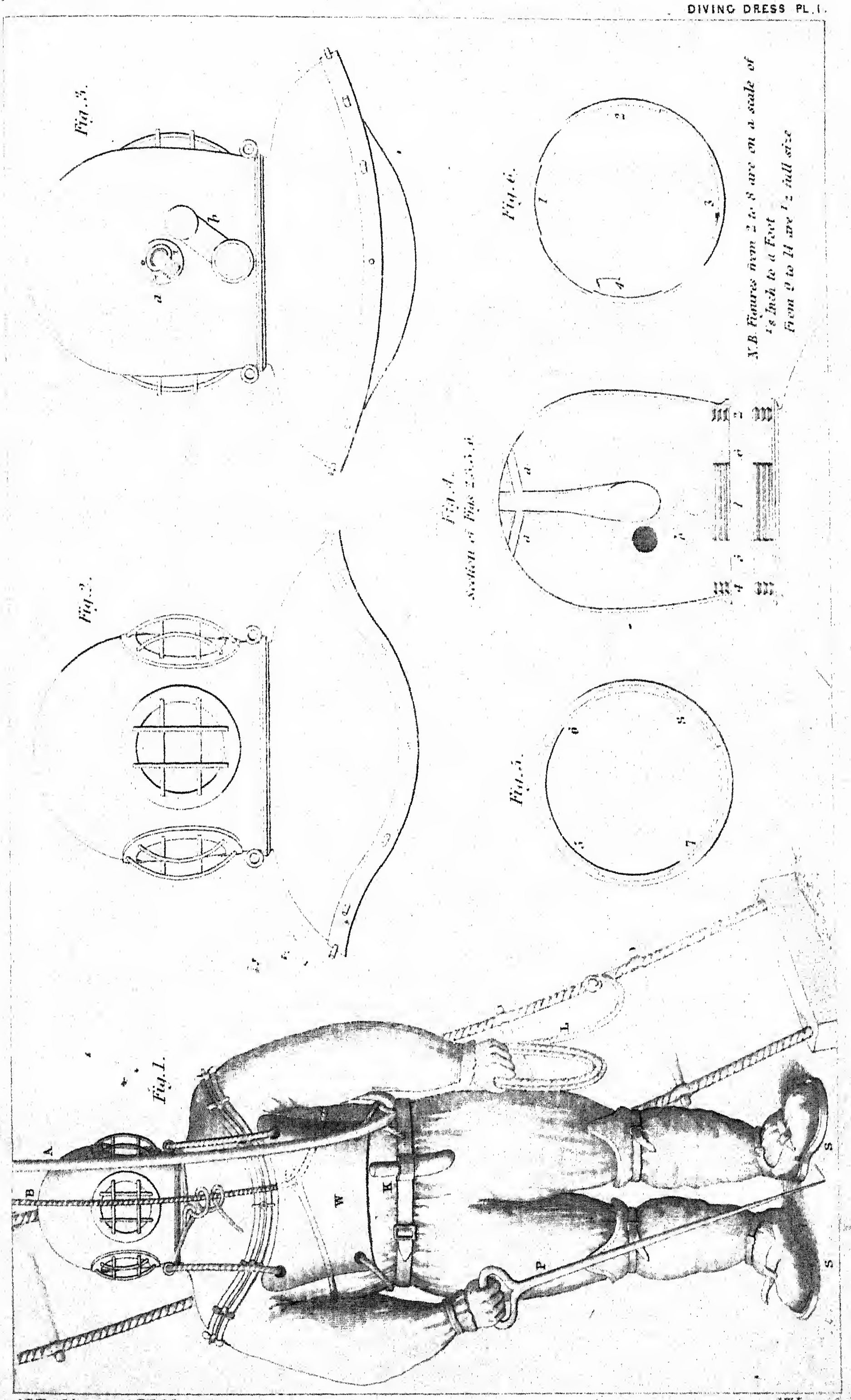
c, c, c. The brass cylinders within the copper chamber, E.

f. The barrel for receiving the condensed air from the cylinders.

g. Nozzle at end of ditto, for screwing on the end of the air-pipe, the other end being fixed to the diver's helmet.

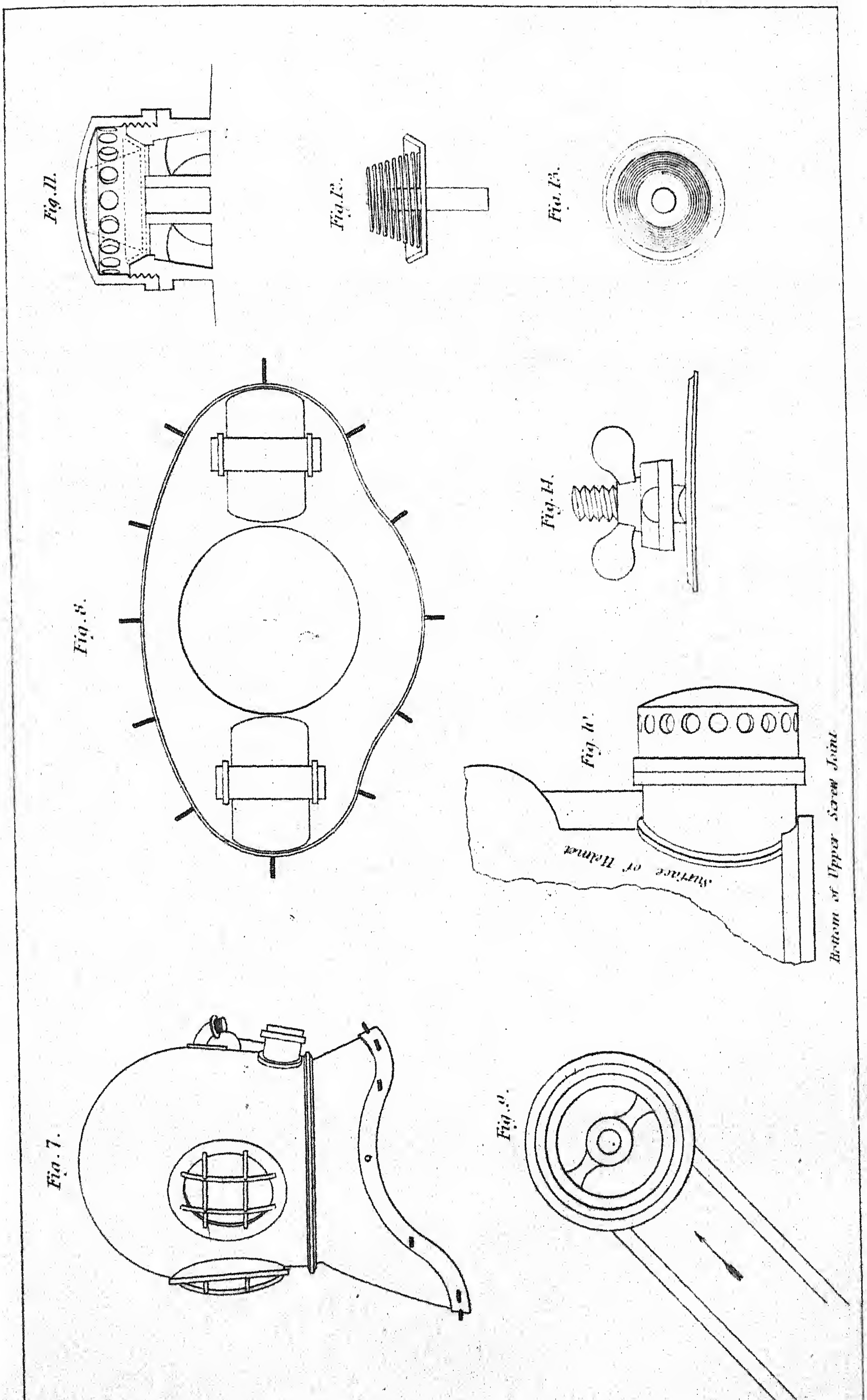
h. Suction-pump for drawing up cold water from the sea by the flexible pipe, *i*; the water is discharged into the copper chamber, E, by the metal pipe, *k*; vertical motion is communicated to the pump-rod, *m,* by the eccentric circle, *n.*

l. Fly-wheel at end of axle.



G. R. Hutchinson Capt. R.E. del. J. W. Lowry fc.

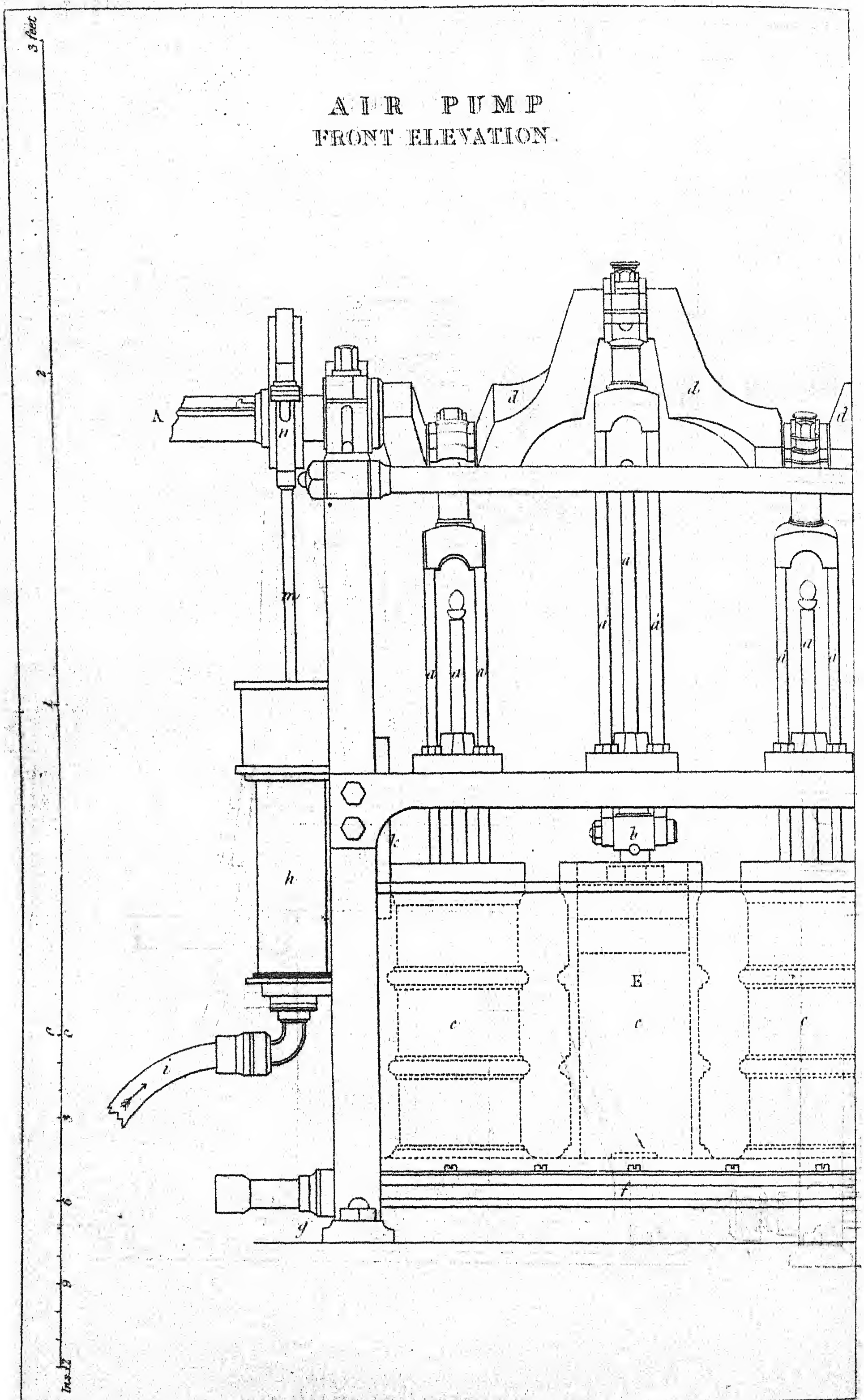
John Weale 59 High Holborn, 1846.



G. R. Hutchinson Captⁿ R.E. del. J.W. Lowry fc.

John Weale 59 High Holborn 1846.

AIR PUMP
FRONT ELEVATION.



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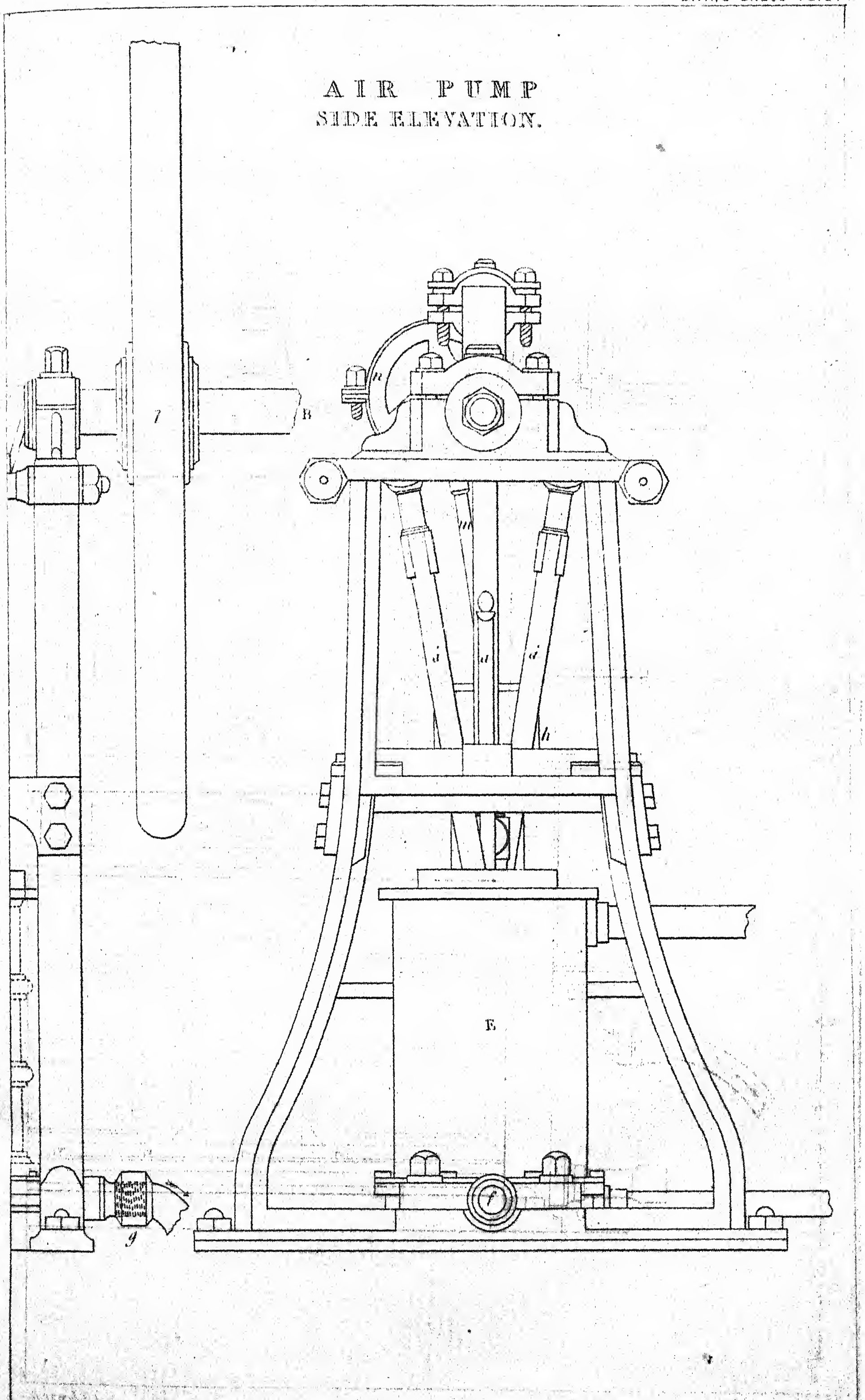
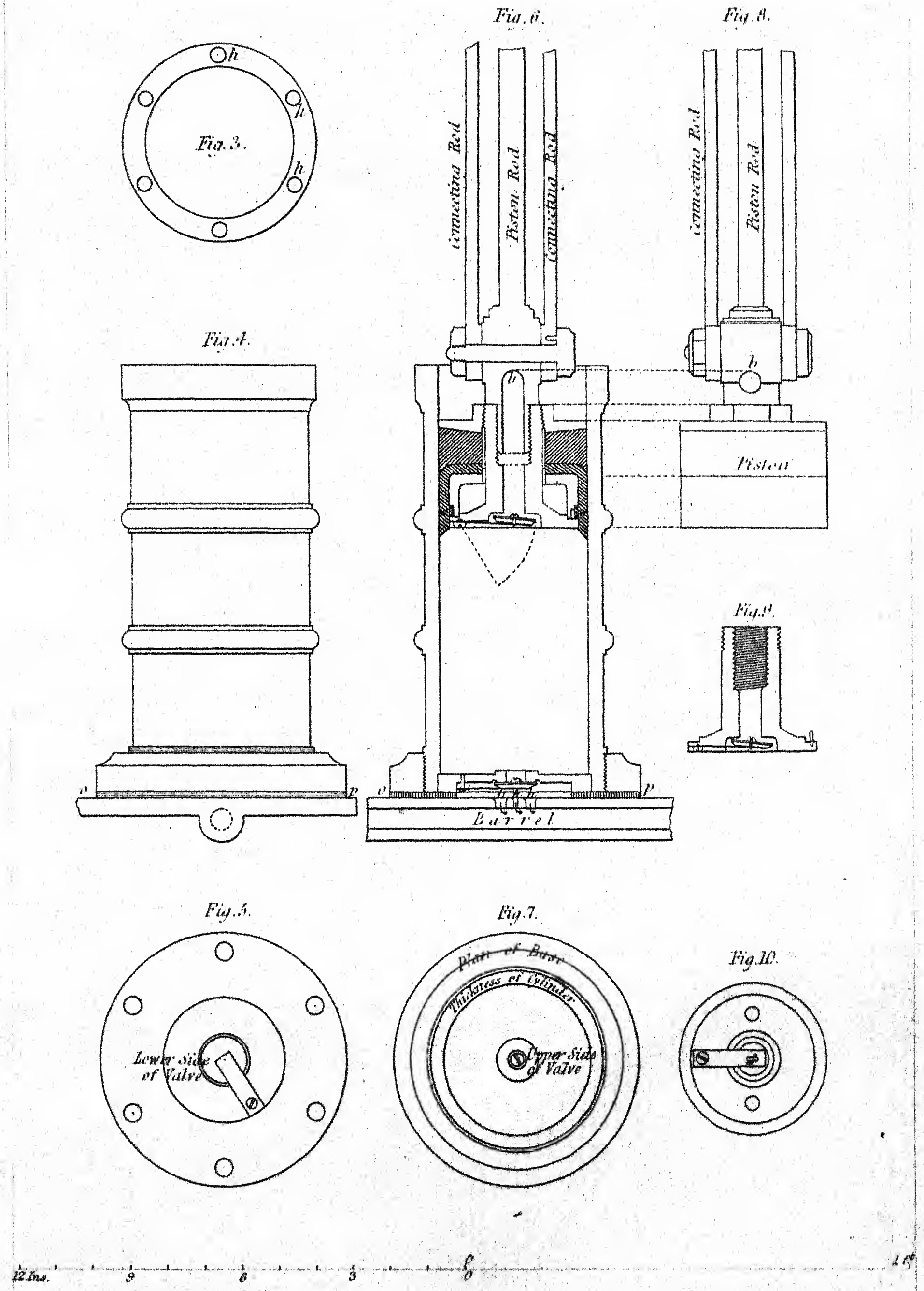
AIR PUMP
SIDE ELEVATION.



J.W. Lowry fc

John Weale 59 High Holborn 1846.

DETAILS OF AIR PUMP, CYLINDER & PISTON.



G. R. Hutchinson Capt. R.E. del.

J. W. Lowry fc.

Jn. Weale, 59, High Holborn, 1846.

Plate IV.

Fig. 3. Plan of top of cylinder. The circular holes are for fixing a screw-wrench to screw the cylinder to its bed.

Fig. 4. Side elevation of brass cylinder. *o p* represents a leather washer, upon which the cylinder is screwed, to prevent the escape of the condensed air.

Fig. 5. Plan of under side of cylinder, shewing the valve.

Fig. 6. Section through cylinder and part of barrel, with the piston drawn up, shewing its valve, and the valve attached to the bottom of cylinder. *h*. Orifice and tube for the entrance of fresh air. *h, h, h*. Orifices below for the passage of condensed air into the barrel. This section represents the mode of screwing the piston-rod and piston to each other, and of securing the pieces of leather of which the piston is formed. *w, w*. Section of a circular wire spring which forces the under leather of the piston against the cylinder.

Fig. 7. Plan or horizontal section through the cylinder, shewing the upper side of lower valve.

Fig. 8. Side elevation of piston, and part of rods.

Fig. 9. Section through the metallic (brass) part of piston, with the pieces of leather, composing it, removed: the inner screw receives the piston-rod; the outer one is screwed into a brass cap or plate forming the top of the piston.

Fig. 10. Plan of the lower part of the piston, shewing the under side of valve.

DRAINING may be generally considered thus: with reference to—

A. Military purposes, B. Sanitary do. C. Economic do.	as the process of carrying off water as expeditiously as possible; in opposition to arrangements for irrigation and to dams, of which the object is to *retain* water and all control over its application.—See 'Dam.'

These may be further subdivided thus:

A. *a*. Draining an inundation, lake, &c.

„ *b*. Diverting the course of a river, stream, &c.

„ *c*. Draining field-works.

„ *d*. Do. the ditches and quarries of permanent works whilst in execution.

„ *e*. Do. fortifications, as complete.

„ *f*. Do. unhealthy positions.

B. *a*. Draining unhealthy districts.

„ *b*. Sewerage.

C. *a*. Territorial. Reclaiming marshes, fens, bogs, &c., for enlargement of territory on all scales—from that executed in Holland, for hundreds of square miles—or in our own colonies of Berbice and Demerara—down to the space to be recovered for large Government establishments, or for fortifications; or that of the private estate, or mere plot, to be rendered available for building ground.

„ *b*. Agricultural. Drying up the above descriptions of ground to afford the soil the advantages of warmth; of opportunities of exposure to contact with fertilizing matters (gaseous, fluid, and solid); and of killing the rank aquatic plants which are too powerful for co-existence with, or are otherwise obnoxious to, those which it is desirable to cultivate.

B and C are very generally connected with such embankments as will keep out the sea; and these embankments have, usually, such sluices as admit or exclude the external waters at pleasure.

The covering in of drains, or leaving them open, is a question, at times, of necessity (as generally in B); at others, of economy,—the decision resting on the balance of profit and loss between the value of the unoccupied surface and the expenses of covering; and in other cases of mere convenience—as in the more expeditious cases of military draining, A*a*. A*b*., where nothing else could be gained by such an operation.

All that concerns this part of the work will be A*a*. A*b*. A*c*. A*f*., the remainder belonging to Permanent Works, except as relative to 'Sanitary Precautions,' which see.

A*a*. A*b*.—These are most likely to occur in facilitating siege operations, either by depriving the enemy of the means of flooding the approaches, or to lay open an otherwise inaccessible front. From the probable nature of the case, the measure to be adopted will most likely be of the simplest description, though in determining the volume and course of the stream, care should be taken, if possible, to reserve some control as to continuance; and to calculate effects not only as to the purpose in hand, but on communications in general, by such a body of water entering a new channel. If possible, also, the excavating parties should commence at the end farthest from the point where the waters are to be let out.

The 'measure' above mentioned is the determining a new channel approaching, on the whole, to the straight line A B (figs. 1, 2), by which the contents of the lake, &c., A (which has hitherto received all the waters on the right of the watershed C C), are to cross that line C C, and join the new course B, which may be a gully, or streamlet, leading to quite a different part of the country.

Now it by no means follows that the straight line A B will be the best, though, geometrically, the shortest. Greater facility in excavation, less amount of cutting, greater suitability of ground for the channel, &c., &c., may warrant even such a deviation as A D B; which line need not be constantly in the same plane with A B (as A G H I J B, fig. 3); nor always on a winding course inclined to the horizon at one unvaried angle (as A N′ M′ L′ B, fig. 4),—but so regulated, if possible, that where the ground is not homogeneous as to the consistence of its material, the steepest parts shall be where the rock or soil is hardest, and thus meet the most violent action with the greatest resistance. Nevertheless, the best course will generally be between such limits as are given by A B, A′ B, of figures 3, 4, respectively; as, though much latitude may be allowed the line A D B, fig. 2 in plan, very little can be admitted in section.—See 'Levelling.'

Fig. 1. Section of Fig. 2.

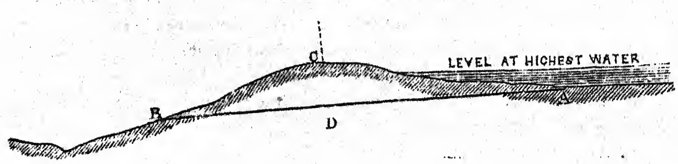


Fig. 2.

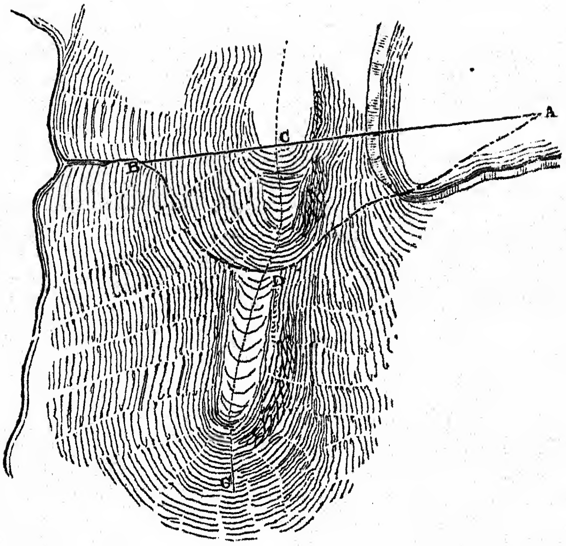


Fig. 3.*

Shewing a line A H I J B in the plane W X Y Z; which line varies in inclination at every point, between 0° and A B O, the angle which the plane W X Y Z makes with the horizon; being 0° at *a* H *a*, *b* J *b*; and = A B O at I, G.

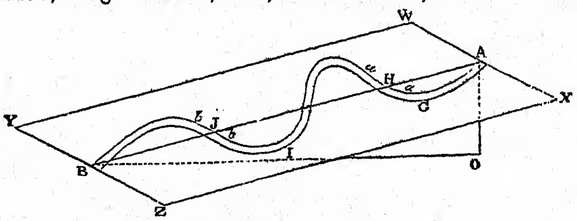
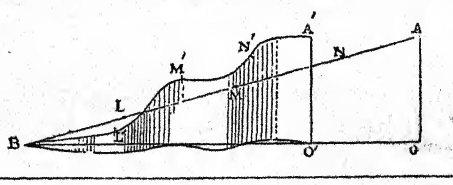


Fig. 4.*

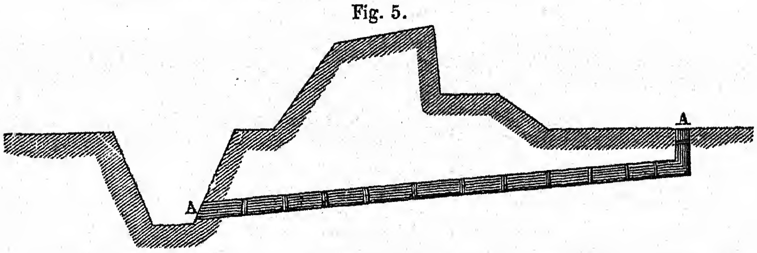
Shewing a line A′ N′ M′ L′ B at one uniform angle (= A B O) with the horizon, as if given by the edge A N M L B of the triangular slip of paper A B O, folded as A′ B O′.



* These diagrams are also of great importance in laying out roads.—See article 'Roads.' In this last they may be applied to several adjacent and consecutive planes dipping in various directions; but in determining water lines, all these planes can only dip in one *general* direction so as to continue the course downwards.

A*c*.—This can never be very extensive. In small works, where the object is to keep the interior dry, the drains may consist of large fascines, A A (made of branches that would be considered rather too thick for ordinary purposes), let into the ground. Should this be insufficient in larger works, trenches should be cut, and filled in with middling sized gravel or small rubble:—this is called 'Rubble Draining:' in both cases, leading from the lowest point of the space to be drained, they can pass through the rampart into the ditch.

Fig. 5.



The same can be applied to draining ditches, but then the latter mode is most likely to be in requisition.

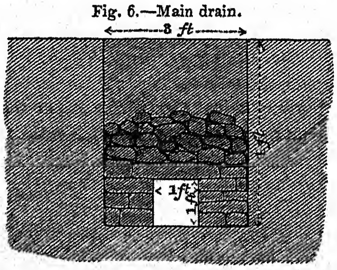
A*f*.—This is mentioned as only applicable on a small scale in the field: where unhealthiness springs from the dampness of the ground, it is more likely to be increased than reduced, in the first instance, by disturbing the soil; especially if there is much decomposed vegetable matter to be displaced. The excessive sickliness at Corfu and Ceylon amongst the troops whilst new roads were being cut under this circumstance is decisive as to 'fact,' whatever may be the theories as to the cause, or even existence, of malaria.

If an extensive position, likely to be held for some years, is to be drained, the troops not immediately wanted should be removed, as much as may be, during the execution of the work; the season should also be considered, and the inhabitants of the country should be employed as much as possible. No detailed course can be prescribed as to the arrangement of the drains, but it is probable that the following sketch of what is done in some of the Irish bogs may be applicable in a general way.

MEMORANDA* OF THE METHOD OF DRAINING LAND IN PART OF THE COUNTY TIPPERARY.

"A general course for the water having first been found,† the levels of the ground are then taken, in order to find the best position for the main drains, for which excavations averaging 4 feet in depth and 3 feet in width are made: these excavations are then built in with dry masonry so as to leave a water-course 1 foot high and wide, covered over with rough flagging or other stone; they are then filled in further with loose stones, and covered with earth: these drains are sometimes 6 feet below the sur-

Fig. 6.—Main drain.



4 ft. to an inch.

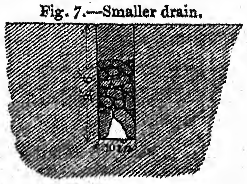
* By Capt. J. Freeth, R.E.

† Where it is not intended to change the water-shed, this 'general course' will be often already decided by the old natural water-courses, which may be, in most instances, much improved by clearing and deepening in places, so as to *approximate* to the line A B, in figs. 1, 2. But if it be desired to alter the water-shed,—as for instance from a lake on one side to a river on the other,—then a new channel must be provided, as shewn in the paragraph to which figs. 1, 2, refer.—R. J. N.

face of the ground, and, where there is much water, the dimensions are increased to 1′ 6″ × 1′ 4″.

"For the smaller drains, excavations are made 2 feet 6 inches to 3 feet deep, and 10 inches to 1 foot wide; at the bottom of them stones are placed with the edges leaning against each other, so as to form an arched way for the water to run through, and they are filled in, to within about 1 foot from the surface, with loose stones, broken to about 3 inches cube.

Fig. 7.—Smaller drain.

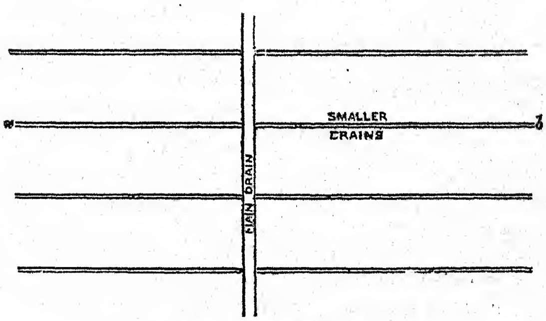


4 ft. to an inch.

"These drains are placed in ordinary ground about 18 feet apart, but in very wet ground not more than 15 feet, sufficient fall being given to prevent the water from lodging in them: they are led into the main drains as shewn below.

Fig. 8.—Section through *a b*, fig. 9.

Fig. 9.



Scale 50 feet to an inch.

"The expense and mode of operation will of course vary according to the description of country, the system shewn above being adopted in ground where there is a supply of stone raised in the excavations which is nearly sufficient for filling in the drains." R. J. N.

E.

ELECTRICITY—as in various degrees called into existence on any change in the mechanical or chemical construction of bodies: and the object of all electric apparatus (other than those for scientific investigation) is to *obtain control* over its direction when developed by natural causes, or over its action when produced artificially.

As far as military purposes are at present concerned, we have four principal subjects of application for what practical knowledge is available on this head.

1. The Lightning Conductor.
2. The Electrotype.
3. The Explosion of Mines.
4. The Electric Telegraph, as associated with railroads considered as military communications.

In No. 1, the object is to permit a free neutralization of the electric forces, and thus, as it were, to afford a ready outlet to a violent agency that may do mischief to an indefinite amount, if not provided with such means of escape,—in short, "to make a bridge of gold for a flying enemy," though it will be shewn shortly that gold is no longer considered the best material for that purpose.

In Nos. 3 and 4 the object is to apply to the work intended for it this same power when created and accumulated to any desired extent, by apparatus for effecting the changes before mentioned in either the mechanical or chemical constitution of certain bodies.—See 'Telegraph' and 'Voltaic Electricity.'

LIGHTNING CONDUCTORS.

The following notices are intended to embody such principles as are involved in arrangements for lightning conductors. The practical parts have been abridged from Sir W. Snow Harris's different works, especially that on Thunder-storms; though, respecting any difference there may be between the more theoretical portions of the subjoined and his, it is to be observed, that in arguing on the general development of electricity, that distinguished author's reasoning is built on the Leyden hypothesis of opposed surfaces.

The distinction between 'Conductors' and 'Non-Conductors' is arbitrary; and the line of conduction in all bodies may be considered to lie along the polarized moleculæ composing that line,—whether we refer to metals as so-called 'Conductors,' or to the air as an assumed 'Non-Conductor:' in both the electric action passes from atom to atom along the course taken, though with far greater rapidity in the one case than in the other. In this view of the atmospheric particles forming lines and (thence as connected laterally in mass) *spaces* of conduction, it is considered that electricity is being perpetually evolved from the earth (as from a huge electric machine) by the incessant changes in the mechanical as well as chemical condition of its constituents; such changes, for instance, as those accompanying variations of temperature produced by the enormous extent of evaporation* from the land and fresh water, as well as from the ocean,†—by the absorption and re-irradiation of solar heat; by the escape of central heat; or by the decomposition and recomposition perpetually in progress over the face of the earth, of all descriptions, from slow putrescence to rapid combustion, &c., &c.,—all of which are, more or less, associated with changes in electric condition.

This excited electric condition of the gaseous or other volatile bodies, thus released in their course upwards through and mixed with the atmosphere, cannot but disturb the electric equilibrium of its particles inductively; and this action continues till the process reaches the nebulous matters consisting of these vapours, &c., condensed into clouds

* It is right to observe, that this direct evolution of electric action by evaporation is in some degree a contested point.

† The evaporation of sea water produces a greater degree of electrical excitement than that of fresh water.—Kane's 'Elements of Chemistry,' p. 203.

by a change of temperature which determines the existence of electric 'matter' in a form of palpable activity: and when these charged masses approach each other, either by electric attraction, or by the motion of air currents or other causes—then the restitution of the integral and original state of the electricity question takes place; the action of which, when of a destructive character, appears and terminates violently, along and at the end of the chain of intermediate polarized atoms of air, &c., in the forms of sheet lightning, forked lightning, or as the fire-ball or 'thunderbolt.' When of a harmless description, it will be as the 'glow discharge'* (*to* a point)—as the 'brush discharge' (*from* a point), or as the 'summer lightning,' which confines its activity within the precincts of the cloud;—these two groups comprising all the known varieties of lightning.

Although the greater conducting power of metals is thus considered as only a more intense and rapid form of induction,—and relative as the expressions 'conductor' and 'non-conductor' are,—yet the difference of those powers in certain bodies is enormous; that of iron, for instance, being estimated at 400,000,000 times greater than that of water.

The following Table gives in an approximate way the order of precedence in conductive power.

TABLE I.†

	Conductors.		Non-Conductors or Insulators.
Most perfect.	All known metals.	Less perfect.	Ice at 0° of Fahrenheit.
	Well-burned charcoal.		Dried vegetable substances.
	Plumbago.		Dried animal substances, generally.
	Burning gaseous matter, as flame.		Parchment, leather, feathers.
	Smoke.		Baked wood.
	Concentrated acids.		Oils and fatty substances.
Less perfect.	Dilute acids.		Silk.
	Saline fluids.	Most perfect.	Fur and hair.
	Living animals.		Dry gases, including air.
	Living vegetables.		Pure steam of high elasticity.
	Wood, in its ordinary state.		Glass and all vitrefactions.
	Snow, and ice from 32° to 0°.		Diamond and transparent gems.
	Water.		Talc.
Imperfect.	Aqueous vapour.		Amber.
	Common earth and stone.		All resins and resinous bodies.
	Dry chalk and lime.		Brimstone.
	Marble and porcelain.		Shell-lac.
	Paper.		
	Alkaline matter.		

The ratios of heat evolved, and of those of conducting power, are shewn as follows.

TABLE II.‡

	Heat evolved.	Conducting power.
Silver	6	120
Copper	6	120
Gold	9	80
Zinc	18	40
Platinum	30	24
Iron	30	24
Tin	36	20
Lead	72	12

* 'Comazants'—'St. Elmo's fires,' &c. † From Harris on Thunder-storms.

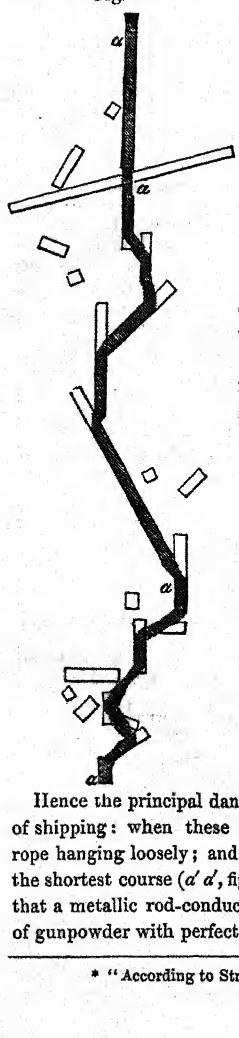
‡ As given in Kane's 'Elements of Chemistry.'

Hence it is unnecessary to use gold or silver, as has been suggested in former times; the power of copper being equal to that of the latter, and superior to that of the former.

As concerns the extent of electric action always in existence, Faraday asserts that there is electricity enough evolved in the decomposition of a single drop of water to form a flash of lightning: and with reference to the rapidity with which it passes, Wheatstone (with an apparatus that enabled him to measure time to the $\frac{1}{152000}$th of a second) determines the progress of accumulated electricity as at times 576,000 miles per second, that of light being 195,000 miles.*

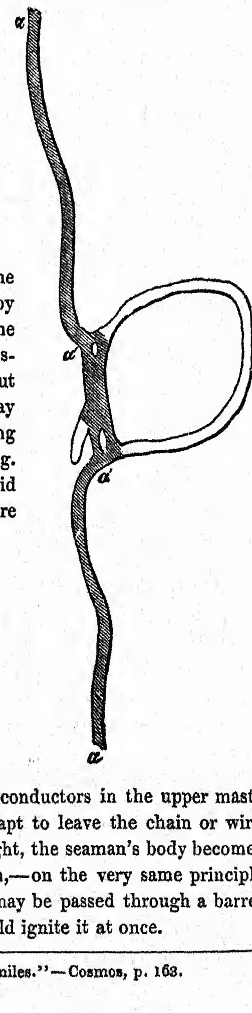
The electric 'fluid' will invariably *select* for itself the line of shortest conduction offered by the best conductors at all near its course in a building, ship, &c.: the following diagrams from an original experiment by Sir W. Snow Harris illustrate this principle fully.

Fig. A.



Figs. A, B.
The shaded part shews the direct track (a a) taken by the electric fluid along a line of metallic conduction, disregarding every thing but its own course. Fig. A may represent the conducting masses in a building: Fig. B, the passage of the fluid across the bight of a wire rope or of a chain.

Fig. B.



Hence the principal danger in using chain or wire conductors in the upper masts of shipping: when these last are lowered, they are apt to leave the chain or wire rope hanging loosely; and when handling this as a bight, the seaman's body becomes the shortest course (a' a', fig. B) for the electric action,—on the very same principle that a metallic rod-conductor of proper dimensions may be passed through a barrel of gunpowder with perfect safety, though a chain would ignite it at once.

* "According to Struve's latest researches, 166,072 miles."—Cosmos, p. 163.

The expressions of the most important electric laws concerning the subjects of this article, as determined *experimentally*,* are as follows; where

C represents conducting power.
D „ distance between two opposed surfaces.
F „ attractive force between two surfaces so opposed.
H „ heating powers, referring to solidity and transverse section.
L „ length of conduction.
Q „ quantity of electricity in the charge.
S „ surface over which Q is spread.

The Attractive Force between two *opposed* surfaces varies—

If between a charged and a neutral free conductor, { directly, as the square of the quantity of electricity, inversely, as the square of the distance, „ as the square of the surface, } or $F \propto Q^2$; $F \propto \frac{1}{D^2} \propto \frac{1}{S^2}$

If between an unchangeable positive and negative surface, { directly, as the square of the quantity of electricity, inversely, as the distance, } or $F \propto Q^2 \propto \frac{1}{D}$

The Conducting Powers of different rods of the same metal vary therefore—

in a higher ratio (apparently) than as the surfaces, though they are not asserted to do so as the squares, } or $C \propto S^2?$ †

They vary inversely as the length; and directly as the square of the diameter of the solid rod, } or $C \propto \frac{1}{L} \propto d^2$

The Heating Effect (referring to solidity) varies—

directly, as the square of the quantity of electricity, inversely, as the area of the transverse section, „ as the length of conduction, } or $H \propto Q^2 \propto \frac{1}{\text{area of section}} \left(\text{or} \frac{1}{\text{diameter}^2}\right) \propto \frac{1}{L}$

APPLICATION OF THE PRECEDING, AND OF SUCH INFORMATION AS EXPERIENCE HAS HITHERTO SUPPLIED.

References.

Table II. Copper is the best conductor: the rods should not be less than ½ inch diameter, if solid; ¾ inch is preferable, and generally ample. If hollow, may be from 1 to 2
Figs. 1, 2, 3. inches in diameter, and about ⅛ inch thick.—See figs. 1, 2, 3, Plate I.

If iron rods be used, they should not be less than ¾ inch diameter when solid: if hollow, not less than 2 inches diameter and $\frac{3}{16}$ inch thick, and jointed as in figs.
Figs. 1, 2, 3. 1, 2, 3, Plate I.—By B. O., 24th July, 1829, $\frac{E}{510}$. "Solid iron rods 1⅛″ diameter,—top of copper,—tipped with gold."

$C \propto S^2?$; $H \propto Q^2 \propto \frac{1}{d^2}$; $C \propto \frac{1}{L}$ } The Hollow Conductor (if sufficiently thick for stability) is better than the solid rod of equal length and weight, because the metal should display as much surface ‡ (in lateral dimensions) as possible consistently with strength, § to reduce the intensity of action on surface, and heating effect in transverse sectional area; but unnecessary length should be avoided.

* The writer of these notices has been gratified, through the kindness of his friend Sir W. Snow Harris, with a sight of the experiments on which the most important of the above formulæ were deduced: it is difficult to conceive any such demonstrations more interesting, or more rigid, than were afforded by this accomplished experimentalist.

† All the formulæ except this are taken from Harris on Thunder-storms, or from his Paper on the Laws of Electricity, Phil. Trans. 1839.

‡ Faraday says, surface does nothing, the solid section being the essential element: p. 399, 'Civil Engineer's Journal,' December, 1850.—*Editors.*

§ In remote colonies, sufficiently good workmanship cannot always be commanded for the tubular conductor: the solid one requires no skill beyond that of a common blacksmith.

Figs. 5-9.

The conductor should involve in its course the principal detached masses of metal in or on the actual walls and framing of the building or ship: if not allowed this course freely, it will be apt to take it in a summary and violent manner.

It should be placed as close as possible to the walls, &c. which are to be defended, —not at a distance from them; and should be carried down at once directly into the ground; and when below the surface, it should then divide into two or more pointed

Fig. 4.

branches (*a a a*, fig. 4) slanting away from the building. If circumstances permit, the lower end should pass into a well, or a stream, or a drain,* or at all events into earth that can generally be kept moist from any neighbouring gutter. It is a useless precaution to pass conductors through glass linings and holdfasts, as has been recommended, since the lightning will always take the direct course down the rod until interrupted; on which last account—

Diagram B.

Chain conductors are very inferior to those of rod, being a series of interrupted conductions from which the lightning is ready to turn aside at any point of contact of the links,—provided that at such point a freer and easier line of conduction be offered by some neighbouring body than what the chain itself affords.

$C \propto S^2$?
$C \propto \frac{1}{L}$
$H \propto Q^2 \propto \frac{1}{d^2}$

The conductor should be attached to the most prominent points of the building (fig. 5): if its length be very considerable, its transverse dimensions must be increased; and in doing this, the provision for a sufficient conducting surface insures that for the heating effect.

In ornamental buildings, such as honorary columns, &c., for the sake of appearance, the conductor may pass down withinside; it must, however, be firmly fixed, and the line of conduction made and kept complete and undisturbed.

In extensive ranges of buildings, all the most prominent points should have long pointed rods projecting freely into the air, at least 4 or 5 feet above the building; and

Fig. 5.

the larger the range the higher they should be. Fig. 5.

It does not appear that any single conductor hitherto made can insure beyond a horizontal radius of 40 feet: hence, in practice, less should be taken; though a wider range may be allowed if the roofs be of zinc, lead, copper, or any other metal in *well-connected* sheets; or if the ridges and hips only be thus guarded, and the whole well joined to the conductor, and to iron gutters and pipes, now commonly used, and a free passage be provided to the ground at different places. The points of contact must be numerous to reduce the heating effect (or chance of fire) at such points, as the whole electric action will condense there, having still to pass through them on its way down. There is no reason why lightning conductors should not be painted or lacquered.

In addition to the diagrams given in figs. 1–3 (Plate I.), shewing the construction of hollow conductors for buildings,—those for the protection of shipping, figs. 6–9, are likewise noticed as probably providing for such complicated cases as are likely to occur in extraordinary occasions on land,—as in the case of flag-staffs with tops, &c., &c.

Plate I.

Fig. 1. The mode of joining two lengths of copper tube (*a*, *b*) by means of a double screw (*c*) with a shouldered collar (*d*).

Fig. 2. The staple (*a*) by which the conductor is supported at the joints and fixed to the wall.

* By B. O., 18th March, 1846, $\frac{E}{406}$. "Covered cisterns are to be preferred to open trenches, as being less liable to evaporation;—that there be a man-hole; and that all Storekeepers, Barrack-Masters, or others in charge of buildings with conductors, do by weekly or daily inspection ascertain that the cisterns are kept full; for which they will be held responsible."

Fig. 3. The head of the conductor.

Fig. 4. Conductor complete, shewing the lower termination (*a, a, a*), as buried in the ground, or received in water.

Fig. 5. Application of conductors;—the points *a, b, c, d, e,* &c. connected by bands of metal (*c n, d t, e h,* &c.) into one general whole.

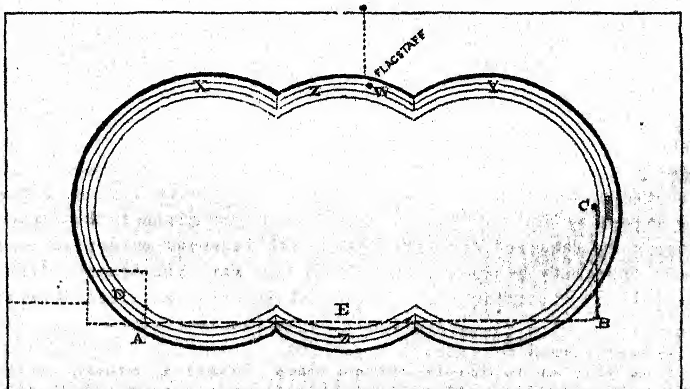
Fig. 6. Ships' conductors, consisting of two stripes of sheet copper, from 1·5 to 5 inches wide, and from $\frac{1}{8}$ to $\frac{1}{16}$ inch thick, in lengths of 4 feet. They are let double into a groove in the mast, so as to insure continuity of conduction by breaking joint, as shewn in the figure: these stripes are kept in thorough contact, and are secured to the mast by copper nails, 6 inches apart, in the drilled and countersunk holes (*a, a*). The upper surface of the upper piece (A, A) is slightly rounded so as to conform to the surface of the mast in transverse section.

Fig. 7. "The cap (*a b*) and the hole (*b*), through which the moveable mast (*e x*) slides, are furnished with similar plates: these are led from the square hole at *a*, by which the cap (*a b*) is fixed to the head of the mast (D), into the round hole at *b*; and there is a lining of copper in this part of the hole next to the conductor at *b*, by which the metallic line is continued to the next mast (D)."

Figs. 8, 9. "The bolts (*a, b, c, d, e, f,*) passing through the ship, and in which the general line of conduction terminates, are clenched upon metallic rings and plates, in connection with the copper sheathing; and there are additional bands (*m n*, fig. 8) leading from the fore-mast and mizen-mast directly to the stem or stern under the decks; other bands (*g h*, fig. 9) traverse the beams, and they all terminate in the sea by bolts clenched on the copper sheathing."—"Fig. 9 is a section suited to the beams abaft each mast."

Memorandum of damage done to one of the Towers on the Coast of Ireland, 13th March, 1844.

The truck of the flag-staff was destroyed,—the rest left uninjured; the ashlar masonry at the foot of it (w) a good deal shaken.



From W the electric matter forked right and left, disturbing the iron racer (4 inches broad × $1\frac{1}{2}$ thick) at X, and at C breaking out a fragment weighing about 4 lbs., which it hurled over the parapet (4 feet high) to a distance of about 50 yards in front. All this was done to find a passage for itself through the stone banquette (18 inches high) on which the racer lies, to the mouth of the lead water-pipe at the foot of this banquette, just under C,—and destroying the intermediate masonry in so doing.

From C the discharge followed the large leaden pipe (C B A, 3 inches diameter) to A, where it projected over the tank (D), but without touching it;—thus isolated, at A the pipe was burst: no further trace of electric action could be discovered,—though, from the condition to which the pipe was reduced, it was a happy circumstance that the lightning avoided the magazine at E, towards which there was no very obvious reason why it did not turn.

N.B. Proper conductors have been since fixed, and in connection with the principal metallic masses.

Sir W. Snow Harris's principles and details have been for some time adopted by the Ordnance, as at Devonport; and by the Treasury for the light-houses at the Bahamas. R. J. N.

ELECTROTYPE.*

The application of voltaic electricity to the art of copying is a branch of the larger subject which embraces the art of working in metals, aptly termed Electro-Metallurgy by Mr. Smee, to whose researches, and those of Professor Grove, the discovery is greatly indebted for the rank it holds.

Electrotype—copies by precipitating metals from solution, either upon the object to be copied, forming a coating over it, which when removed is of course a matrix or mould;—into which metal is again thrown from solution, and becomes a duplicate or copy of the original;—or by precipitating the metal into a mould formed by any other means.

Metallic substances are most easily copied, because from their conducting powers they become part of the voltaic circuit; but other subjects, as busts, vases, or casts of any kind, or fossils, or objects of natural history, may readily be made recipients of the deposit, by coating them with some conducting substance.

APPARATUS.

It would be impracticable within the limits of this article to detail the various kinds of batteries, or arrangements, or forms of plates; they are described in numerous works of easy access,† and have been varied at the discretion, almost the fancy, of the operator. It is sufficient to say that the battery known as Daniell's has the greatest *constancy* of action, and that Grove's affords the greatest *intensity:* but *quantity*, which is the element most required in the operations of electro-metallurgy, is most advantageously procured when working on the large scale, from the construction proposed by Mr. Smee, because quantity bears a direct relation to the extent of surface in the plates; and Mr. Smee's dispenses with the interior porous vessel, which cannot conveniently be procured or used of a large size. This battery is besides remarkable for its simplicity of construction and application; and though it has not

* By Major Larcom, R. E.

† Among which may be especially mentioned Kane's 'Elements of Chemistry,' Daniell's 'Chemical Philosophy,' Smee's 'Electro-Metallurgy,' and a very modest little work, Walker on 'Electrotype Manipulation,' together with occasional Papers in Scientific periodicals.

the constancy of Daniell's, or the energy of Grove's, it may be kept in active operation for a considerable time, when supplied with a sufficiency of acid. For, although quantity is the most important property in electro-metallurgy, all are concerned in the successful practice of it: and all the batteries may be greatly modified in their effects, by the nature, strength, and temperature of the solution from which the deposit is to take place, as well as of that which excites the battery,—the size of the plates, the size, and even the form, of the object to be copied, as well as the length of wire through which the circuit is to be made. By different combinations of these elements, valuable results may be obtained from any of them; Mr. Smee states, in fact, that with any sized negative plate, with any amount of salt in solution, with any sized battery, and at any temperature, we can obtain the reduction of any metal, in any state we please. The operator, therefore, must not expect to find any one process suitable to every application of electrotype, but, making himself master of the principles which are common to all, must apply to the best advantage the means which circumstances place at his disposal.

The first example of electro-metallic deposit, though accidental, points indeed to the general circumstances necessary for its production. Professor Daniell, in the course of his ordinary experiments, observed that the copper deposited on the outer vessel of his battery, from the dissolved sulphate which filled it, contained, when removed, an exact impression of various minute scratches which happened to be upon the vessel. This outer vessel was itself of copper, and if now, instead of copper, we make the vessel of glass, or porcelain, or protected wood, immerse a piece of copper into the solution of sulphate, and connect it by a wire with the zinc within the porous tube, the deposit, which formerly took place on the vessel, will take place on the piece of copper, and produce a mould, which being removed, and itself connected with the wire, will in its turn receive the deposit, that deposit becoming a copy of the original; the strength of the solution being maintained by adding fresh crystals of the sulphate in the usual way. (See fig. 1, Plate I.) What is here described of copper may be applied to the deposit of any other metal, either upon metal, or upon any other substance properly coated, by a due arrangement of the solution and of the plates: but it is proposed here to pursue the subject chiefly as to copper, as most generally useful.

It may here also be said, that the moulds may of course be made of any other substance, if more convenient, as plaster, or any soft metal, by pressure or fusion. In the latter case, the metal must be one which will not be acted on by the solution into which it is to be plunged. In the case of plaster, it must be saturated with oil, or coated with varnish, and all such non-conducting substances must be rendered conductors by a coating, such as black-lead, which may be laid carefully on by a camel-hair brush, and presents a smooth polished surface. A beautiful coating may also be given to some minute subjects by reducing metal from a solution chemically. This is peculiarly applicable to delicate membranes, or objects which will not bear even the brush. A very elegant mode of accomplishing this has been introduced and patented by Mr. Parkes, of Birmingham, thus described by himself:

"A solution of phosphorus is prepared by adding to each pound of that substance 15 lbs. of the bisulphuret or other sulphuret of carbon, and then thoroughly agitating the mixture. This solution is applicable to various uses, and amongst others, to obtaining deposits of metal upon non-metallic substances, either by combining it with the substances on which it is to be deposited, as in the case of wax, or by coating the surface thereof. Any of the known preparations of wax may be treated in this way; but the one preferred is composed of from 6 to 8 oz. of the solution, 5 lbs. of wax, and 5 lbs. of deers' suet, melted together at a low heat, on account of the inflammable

nature of the phosphorus. The article formed by this composition is acted upon by a solution of silver or gold, in the manner hereafter described, with respect to articles which have been coated with the solution.

"If the solution is to be applied to the surface of the article, an addition is made to it of 1 ℔. of wax or tallow, 1 pint of spirits of turpentine, and 2 oz. of India-rubber, dissolved with 1 ℔. of asphalte in bisulphuret of carbon, for every pound of phosphorus contained in the solution: the wax or tallow being first melted, the solution of India-rubber and asphalte is stirred in; then the turpentine, and after that the solution of phosphorus, are added. The solution prepared in this manner is applied to the surfaces of non-metallic substances, such as wood, flowers, &c., by immersion or brushing; the article is then immersed in a dilute solution of nitrate of silver or chloride of gold: in a few minutes the surface is covered with a fine film of metal, sufficient to insure a deposit of any required thickness on the article being connected with any of the electrical apparatus at present employed for coating articles with metal. The solution intended to be used is prepared by dissolving 4 oz. of silver in nitric acid, and afterwards diluting the same with 12 gallons of water; the gold solution is formed by dissolving 1 oz. of gold in nitro-muriatic acid, and then diluting it with 10 gallons of water."

It is remarkable that by this process the deposit over every part of the surface is instantaneous, in this respect differing materially from the deposit on the ordinary coating of black-lead, which is gradual, beginning at one or more points, and growing, as it were, over the whole surface.

It must also be remarked, that the deposited metal commonly peels off the objects or mould with great facility, from the film of air which always adheres to it; but as it is sometimes desirable to make the deposited metal adhere, that effect may for most practical purposes be produced by washing the plate with a solution of caustic potash, or with nitric acid, or by heating the plate and plunging it in that state into the solution or into water. This, however, is not always successful, nor, indeed, is it by any means clear that the presence or absence of air is the cause or the preventive of adhesion. In the case of metals, a perfect mechanical polish would seem to be sufficient to prevent adhesion, just as water thrown on a highly burnished plate runs off again without wetting it; and roughness, when produced chemically, so as to expose the crystalline structure of the metal, will no doubt cause the deposit to adhere, but the immersion must very rapidly follow the chemical roughening, or the surface will become oxidized. A very simple mode of roughening is by merely reversing the poles of the battery for a few minutes. The power of separation, however, is all-important, and it has not been deemed sufficient on the large plates of the Ordnance Survey to trust to their polish alone. The mode adopted is to clean out the plate thoroughly with oil, and clean off all the oil which can be removed by rubbing; then brush the plate carefully with bread, which, when removed as far as possible, appears still to leave some film behind it, for the plate is then heated and a small quantity of wax applied, which, instead of spreading with difficulty, flashes readily over the plate. This wax is then removed as far as possible, the plate continuing heated; but some minute quantity would appear still to remain, probably filling the inevitable flaws and roughnesses which exist on the best copper. Care must be taken not to touch the plate after it is cooled, or partial adhesion takes place on the parts touched. There is no portion of the whole process of electrotype which requires more care than this. For want of attention to it, or the application of improper means, many persons in endeavouring to multiply copies have entombed their work for ever. The adhesion when under command, however, is very useful for backing plates or casts, &c.; and lest the deposited metal grow round the back or

edges of the plate, it is necessary to coat those parts with varnish or grease, which prevents the deposit taking place.

The form of Daniell's battery may be modified when it is more convenient to place the object in a horizontal position by throwing a porous diaphragm horizontally across a flat box, instead of using the vertical porous tube, or in various other ways which will occur to every operator in the course of his work. The principle, however, common to all this class of apparatus, which has been called *the single cell*, is, that the metal is precipitated at the negative pole of a simple battery; but it will be found that in whatever way a metallic substance can be rendered negative, so that hydrogen shall be evolved at it, there will the metal be precipitated.*

We may therefore use any battery which is sufficient to decompose acidulated water between platinum poles, and it will be found that metal will be deposited at the negative. Here is presented an immense advantage. We can separate the battery from the decomposing *trough*, and instead of replenishing the solution by adding crystals or by other mechanical means, we can use the affinity of metals for oxygen to effect their decomposition; and for the positive platinum pole substitute a plate of the metal we wish to precipitate, *i. e.* the same as in solution. Then, as the metal is deposited from the solution, the oxygen and acid being set free, will dissolve the positive plate, and maintain the solution of the same strength. (See fig. 2, Plate I.)

The form of the precipitating trough must depend on the size and form of the object to be copied; the solution,—on the metal to be thrown down. The battery may vary also, always remembering that quantity is more concerned in electrotype operations than intensity. The intensity we can vary by increasing the series, by using different exciting liquids in the battery, or diminishing the distance between the plates in the trough; the quantity, by changing the relative size of the plates in the battery, by joining the zincs of several pairs, or by increasing the strength of the battery liquid. When the operations are to be of long duration, it is important to adopt the arrangement which will give the most economical amount of power. This may also be obtained in most cases from a single pair, always having relation to the surface intended to receive the deposit; besides which, a certain degree of density or 'tension' of electricity exterior to the battery would appear necessary; but it may be interfered with by the resistance of the solution, because solutions, like metals, are subject to variety in their conducting powers, and the passage of the current may be resisted by various causes; among others, by the distance through which it has to pass, the nature, the strength, and the temperature of the solution; by altering the one or the other of which, the resistance may therefore be diminished. It is also to be remarked in reference to the solution, that the presence of metallic particles in the solution, such as sulphate of iron added to a weak solution of sulphate of copper, for example, will facilitate the deposit of copper.

LAWS.

It is desirable to explain succinctly the laws which regulate the deposit of metals from their solution, a due knowledge and recollection of which will guide the operator in the use of them, as a knowledge of the principles on which batteries and other apparatus depend will guide him in using the one or the other. Mr. Smee has reduced them to three.

* It may here be remarked, that for convenience, throughout this article the composition of the salts is spoken of as formerly understood, not according to the newer theory, by which sulphate of copper, for example, consists of sulphuric acid + oxygen + copper instead of sulphuric acid + oxide of copper—the practical results being, for the present purpose, the same.

1st. The metals are thrown down *as a black powder* when the current of electricity is sufficiently strong, in reference to the strength of the solution, to cause hydrogen to be violently evolved from the negative plate of the decomposing cell.

2nd. They are thrown down *in a crystalline* state when there is no evolution of hydrogen, and no tendency to it.

3rd. They are thrown down in a *reguline* state (*i. e.* having the properties of ductility and malleability) when hydrogen is on the point of being evolved, and when the minutest quantity of gas begins to appear at the negative plate.

Here then we require the combined influences of quantity and intensity, and are guided to the best arrangements. We require sufficient strength in the battery to act upon and dissolve the replenishing plate. Now if we pass a large quantity of electricity through a weak solution, we shall have the metal deposited in the utmost state of brittleness. The reverse will produce large crystals of the utmost hardness. The principal powers of change we possess are, the size of the battery, the strength of the solution, the arrangement of poles in the decomposing cell, and the temperature of the solution.

We can obtain the black powder

1st. *From any given solution*, by increasing the intensity and quantity of the battery, by a series, by altering the size of the negative poles, and by increasing the temperature.

2nd. *With any size of the negative plate*, by increasing the intensity and quantity of the battery, by increasing the positive electrode, by weakening the solution, adding to its acid, and approximating the poles.

3rd. *With any given battery* sufficient to decompose water, by diminishing the size of the negative pole and increasing the positive, by approximating the poles, or weakening the solution with dilute acid.

We can obtain the metal in a crystalline state

1st. *With any given solution*, by increasing the quantity and diminishing the intensity of the electricity, by increasing the positive and diminishing the negative pole, and approximating them.

2nd. *With any given negative plate*, by diminishing the intensity of the battery, enlarging its size, saturating the solution with the salt, enlarging the positive plate, and approximating it to the negative.

3rd. *With any given battery*, by strengthening the solution, diminishing the negative electrode, increasing the positive, and approximating them.

Our great object, however, in electrotype is to obtain metal in the reguline state, *i. e.* to obtain the exact point of evolution of the hydrogen, and it is by no means easy to lay down any general rule. If it be too abundant, we may increase the negative pole or diminish the positive. But if we wish to have the poles of the same size, which is often indispensable, we may reduce the size of the battery plates, or weaken its exciting acid. Variation in the distances between the poles will also regulate the evolution of hydrogen sufficiently in some instances; or supposing all these impracticable or inconvenient, we may keep the evolution under tolerable control, merely by regulating the strength of the metallic solution, and the quantity of acid it contains. The following experiment exhibited these laws in a very simple way. A slip of copper was immersed in a tall jar having a stratum of highly acidulated sulphate of copper at the bottom (about 2 inches in height), another stratum of solution saturated with the salt, a third of the same solution diluted with an equal quantity of water, and a fourth diluted with twice its quantity of water. A slip of the same size formed the dissolving plate, at a distance of half an inch. The above, connected with Smee's battery, in a solution of water 30 : 1. sul. acid, arranged for

quantity. At the bottom, the quantity deposited was small and crystalline. Between the saturated and half-saturated solutions it was most abundant and elastic. The next above was spongy, and at the top was a dark brown powder.

With the same battery arranged for intensity, all other circumstances the same, the effects to the eye were very similar, but the deposit was more copious.

The deposit from the semi-saturated solution in both cases was the best, *i. e.* the most reguline, but it became more granular as the intensity increased.

It may be useful to describe the mode of arranging the same battery for quantity and for intensity. In the first case, the zincs are connected with each other, and the plates of platinized silver with each other, as in fig. 3, Plate I. In the other, the zinc of the first pair is connected with the platinized silver of the second, as in fig. 4, Plate I. These modes of increasing quantity and intensity may be extended to the connection of any number of pairs, but if the experiment be of long duration and arranged for intensity, it is peculiarly important that the zinc plates should be all of equal purity, for if the existing liquid of any cell become saturated by a greater amount of local action on the zinc, its exciting power will cease, and that cell will become in fact a decomposing trough, depositing zinc on the negative plate. This peculiarly recommends the single-pair arrangement for the purpose of electrotype.

APPLICATIONS.

The principal use which the Engineer Department has hitherto made of electrotype is in the duplication of engraved copper-plates on the Irish Survey, to which purpose, after numerous preliminary experiments, it was first practically applied in 1840, for inserting contours in the county of Donegal.

It affords a mode of multiplying maps *ad libitum*, and preserving the original plate, by providing duplicates from which impressions may be taken, while the original plate remains wholly uninjured. It also affords a convenient mode of representing various kinds of information on the same outline or ground-work; as for example, in the illustrative plates of the Census of Ireland in 1842, the same outline map is used to represent on successive plates the density of population, the extent of education, and other subjects, merely by making as many electrotype copies of the first plate in its outline state as are required, and completing each copy with its peculiar information. A matrix is then taken from each plate, the matrices joined, and the duplicate produced in a single plate, so that, in printing, an impression is taken from the whole number so joined, with each passage of the plate through the press. It also affords great facility for the *correction* of maps, and insertion of new matter, by substituting for the ordinary mode of correction (viz., erasing or scraping out the erroneous work, and hammering up a new surface from the back to receive the correction,) the more exact and less costly mode of merely scraping the erroneous work from a matrix, which yields therefore a blank copper in that place. The smallest spot in the most crowded work, as a house in the midst of a town, for instance, can be corrected by this means, which by the ordinary mode would always require the sacrifice of a greater or less quantity of correct work around it. In this way a plate containing the city of Dublin has been corrected for less than one-fifth the expense of re-engraving.

The battery which has been found most suitable is that of Smee. Its simplicity of construction, requiring but a single cell, was very important in plates of the size required, where porous cells would have been very expensive, if practicable. The cheapness of the exciting acid (sulphuric), and the greater ease of cleaning the single zinc element than the numerous zincs where porous cells are used, with the consideration that quantity was the great desideratum, at once recommended it, and after

various experiments it has still remained decidedly the best. These experiments resulted in fixing the size of the battery plates, in relation to the surface over which the deposit was to take place, which is 2′ 3″ × 3′ 3″, about 7 square feet, as follows. A pair of silver plates platinized, *i. e.* coated with comminuted platina precipitated from its chloride solution, each 2′ 8″ × 2′, therefore exposing about 10½ square feet of surface, with a zinc plate between them, 2′ 4″ × 1′ 8″, exposing also about 7¾ square feet, *i. e.* equal to the plate which is to receive the deposit, and weighing about 80 ℔s., fixed in a frame (Plate I. fig. 5), were plunged in a cell* charged with water and sulphuric acid in the proportion of 30 to 1,† and connected with the plates in a horizontal decomposing trough, filled with solution kept in a state approaching to saturation by a dissolving plate of rolled copper of the same size as that which was to receive the deposit. Means were also provided to agitate the solution. A sketch is given of the apparatus in Plate II. In the sketch, the negative, *i.e.* receiving plate, is downwards, in which position the copper is deposited most rapidly, and the solution kept in the most equal state; but the copper is very porous, and a far better copper is obtained by placing the negative plate, *i. e.* the plate which is to receive the deposit, upwards: in this position the deposit takes place more slowly, the metal is far more compact, will bear hammering, and the erasures always necessary in engraving; technically speaking, in fact, is in a more reguline state. It is, moreover, free from the danger of receiving the particles of dirt and impurity which fall from the dissolving plate. It may sometimes be convenient to give the new plate a face of this good copper, and thicken it by reversing the plates afterwards; or a thin sheet, of the thickness of strong paper merely, may be formed, and folded round a common plate for printing, as paper is folded round a card for sketching on. This has been frequently found convenient on the Survey. In both positions, however, but especially when the negative plate is upwards, it is essentially necessary to agitate the solution, in order to remove the air bubbles which adhere to the plate, and especially to keep the solution of equal strength and density throughout, as the fluid in contact with the plate rapidly loses its copper, slackens in its rate of deposit, alters in quality, and in time would stop altogether. The troughs are provided with an arrangement for this purpose, and to the apparatus is also added an extremely simple and neat contrivance, by which the acid solution in the battery is kept at the same strength. The whole of these arrangements were due to Mr. William Dalgleish, by whom they were managed. The changes even of temperature were to a certain extent met by this self-supplying apparatus, as during the night, when the thermometer fell, a greater quantity of acid was given into the battery, and maintained the action. The copper is found to be sufficiently good when about 1 ℔. is deposited in 24 hours. This has been tested by rolling and hammering. As a measure of economy it will be found convenient to make the matrix such as will render it useful for other purposes, because, not being easily soluble from its superior purity, it cannot with advantage again be used as a dissolving plate. On the Survey this may be accomplished by making the matrix sufficiently thick to be used as a new plate for engraving on, by merely erasing the relieved work, and putting a face upon it in the ordinary way. If reflecting telescopes should become common, this copper will be most valuable for specula, and it is already sought after by the goldsmiths as an alloy, from its peculiar purity. For economy also in working on a large scale, it will be useful to find a market for the

* This and all the other water-tight boxes and troughs, described in the Ordnance apparatus, are double deal boxes — one within the other, with a layer of marine glue between, which has been found better than pitch, from its elasticity—being thus free from the danger of cracking by any accidental blow the box may receive.

† The acid spoken of in this article is in all cases the ordinary acid of commerce.

sulphate of zinc which is formed in the battery cell, so that its sale shall in part repay the expense of other material. It is probable such a market may be found in the cotton manufacture.

It is very necessary to be careful in selecting pure acid. The sulphuric acid manufactured from pyrites commonly contains a considerable quantity of arsenic, the presence of which is fatal by being precipitated on the zinc plate and causing local action. This is the more dangerous from its insidious progress not being perceived till the galvanic action has been some time in operation. A convenient mode of detecting its presence is to immerse a pair of small plates in a small quantity of acid solution somewhat stronger than that used in the battery; complete the circuit for a few minutes, and then break it, when, if arsenic has been precipitated on the zinc, it will be immediately detected by the local action it causes.

The apparatus figured in Plate II. was erected in 1841, since which it has been found that the constancy of action in the battery may be conveniently maintained, merely by supplying its waste occasionally, provided the quantity of exciting liquid be sufficient; and instead of separate cells of 60 gallons for each battery, as at first used, a cell has been constructed containing 1500 gallons, into which 4 pairs of plates are plunged, each thus having 375 gallons, and the liquid being occasionally maintained by the addition of as much acid as the diminished weight either of the zinc plate in the battery, or the dissolving plate in the trough, shews to have been taken up to form the sulphate, and the working of the apparatus being exhibited on a galvanometer attached to each pair of plates. The large dimensions of this cistern afford the advantage of placing the battery plates in an oblique or horizontal position by a simple arrangement of the mercury, facilitating and maintaining the amalgamation of the zinc, so that, it being no longer necessary to remove the zinc so frequently for that purpose, it may be increased to a considerable weight, and the battery left in its cell for a much longer time.

In this construction also the plates may be made of slips of metal, which, more especially in the negative or silver plate, is of great advantage, from the facility and economy it affords in the operation of platinizing, usually one of much delicacy and difficulty in large plates. In this arrangement the sulphate of zinc which forms in the bottom of the cell is drawn off by a siphon, a false floor being provided to receive the plates. It is not thought necessary to figure this newer apparatus in the present article, as the former is sufficiently effective for all cases likely to occur in ordinary service.

A few lines may, however, be added on the great importance of agitating the solution in the decomposing trough, to which, as well as to the position of the plates in the trough, it will always be found necessary to attend very carefully, whatever arrangement may be adopted for the battery plates. A very simple experiment will shew that the change in the character of the precipitated metal, when the dissolving and receiving plates are in different positions, arises from the changing of the density of different parts of the solution when the battery is in active operation.

If a copper dissolving and receiving plate be placed vertically in a glass jar filled with a solution of sulphate of copper, and attached to a small battery in good working order, and the solution narrowly watched, that portion from which the metal has been precipitated will be seen to rise from the upper edge of the receiving plate to the top of the solution, while a stream of greater density will be seen to flow from the lower edge of the dissolving plate to the bottom of the jar, and in time crystals of the salt become formed at the bottom of the jar, while the solution at the top will become colourless as far down as the upper edge of the dissolving plate; so that if the receiving plate project above the dissolving plate in the solution, it is obvious no

metal can be deposited upon it, although the dissolving plate will continue to be acted on. When the plates are in a vertical position, facing and parallel to each other, the deposit becomes unequal, *i.e.* upon the lower portion it is much thicker than upon the upper: it is generally studded with globular concretions of the metal, and lines or grooves extending upwards, while the upper part remains thin; and when the solution comes to a certain stage of saturation, or rather of exhaustion, it is covered with the sandy deposit, and at last a dark brown powder.

The same inconvenience is felt in the horizontal position, and from the same cause. When the receiving plate is under the dissolving plate, the solution in contact with its surface rapidly becomes of different density in different parts; and as some portions of it are thus more favourable for deposition, a current is established and maintained if the solution is not disturbed. Under certain circumstances, the metal grows vertically in needle-shaped points, to the height of half an inch or more, nearly completing the circuit by contact with the other plate. Under ordinary circumstances, the back of the plate becomes studded with the minute globes before described, which from their lateral growth meet, but have no cohesion, and are in their turn covered with others. Under other circumstances, the plate becomes covered with circular cavities, which become smaller as the metal is precipitated on their upper edge, and at length are covered over, enclosing every impurity that may have fallen. It is obvious that metal so formed must be spongy and useless.

When the dissolving plate is downwards, the dense portions of the solution will subside to the lowest part of the cell, or remain in the hollows of the plate, upon which it will crystallize, while the lighter, from its tendency to rise, causes a current to pass along the surface of the receiving plate, in the direction of its most elevated part, the course of which is marked by the dark colour of the deposit. If it meet with obstructions or hollows on the surface of the plate, it is retained, till reduced to that degree of density at which the granular or sandy deposit takes place; and if the solution should be disturbed before it has been observed, the loose grains are covered with the next quantity deposited, forming a porous or spongy part in the new plate, which, if near the surface, would render it unfit for engraving.

These evils may in some degree be diminished by slow deposit, the solution having greater time to mix. But this is insufficient to obtain the great desideratum of maintaining uniform density in the solution, and removing from contact with the receiving plate that portion from which a part of the metal has been precipitated before it is reduced to that state at which the brown or granular deposit takes place, that is, before the quantity of metallic particles in the solution is so reduced as not to be sufficient to engage all the current, and allow the water of the solution to be acted on.

The remedy for these evils is to be found in agitating the solution, and the result will be more evident with a battery of sufficient power to decompose water violently. In such a battery, if the plate to receive the deposit be suddenly plunged vertically, so as to produce as little movement as possible in the fluid, it will instantly evolve hydrogen, become coated with the dark brown deposit, and gradually covered with granular concretions; but if by some mechanical arrangement the solution be kept in constant agitation, or the plate kept in motion, the deposit will go down evenly, rapidly, and of good colour and consistence. After a small quantity has been deposited, the agitation may be less frequent; but if the plate be removed for a few minutes, and again immersed, the brown powder will again be thrown down, unless the agitation be resumed.

Among other batteries, these experiments were made with one of Daniell's constant batteries in a series of ten cells, each exposing a surface of 36 square inches of posi-

tive metal; the surface of the receiving and dissolving plate being at first each 5 square inches, and subsequently the receiving plate reduced to 2 square inches, the dissolving plate remaining the same. The solution operated on was sulphate of copper acidulated, about one pint in a glass jar, the temperature of which, it may be remarked, was raised 45° in 30 minutes by the operation. The quantity deposited in 10 minutes was about the thickness of strong writing-paper, perfectly solid, reguline, and easily removed from the plate.

From the above it would appear that with the same battery, the same solution, at various degrees of temperature, the receiving and depositing plates of equal or of different size, either of the characteristic deposits defined by Mr. Smee may be obtained, *provided the solution be kept in agitation, the receiving plate first immersed, and the dissolving plate inserted gradually.*

This branch of the subject has been dwelt on at somewhat greater length than would otherwise be necessary, because it occurs chiefly in large operations, and such are most likely to be used in the Engineer Department, whether as in the instances which have led to the present article, in the creation of duplicate copper-plates of considerable dimensions, or in the coating of metallic or other substances used in constructions, with a view to their preservation. To many such purposes there can be no doubt but electro-metallurgy will be applied. The science at present is wholly in its infancy, and in this notice little more has been attempted than to lay down a few general principles which will be found essential in all cases.

It has been proposed to perform the corroding process of etching by connecting the plate to be acted on with the positive pole of a battery, making it, in fact, a dissolving plate; from which various advantages may result in certain cases, as in diamond ruling, where it is desired to obtain a very smooth line, which engravers feel it difficult to obtain by the ordinary means, because the local action constantly produces irregularity, from the adhesion of bells of hydrogen to the sides of the line. This is wholly avoided in the voltaic operation, as the action takes place by direct combination of oxygen with the copper, but without the evolution of hydrogen, producing a line of equal depth, and giving to copper the exactness of steel.

When it is desired to strengthen the original work on a plate, *i. e.* to make the lines on the duplicate plate stronger than they were on the original, it may sometimes be accomplished by charging the old work with ink, and throwing down a thin deposit of copper, which will not settle on the ink, from its oily nature, then removing the ink in the ordinary way, when it is obvious the blank portions of the plate are raised; or conversely, the engraved work is deeper; and accordingly when the plate is again submitted to the process, the result will be a stronger work on the duplicate plate. To avoid all risk of adhesion and consequent injury to the original plate, it is desirable to take a facsimile duplicate in the first instance, and work upon that duplicate, leaving the original quite safe.

A new species of engraving has also resulted from it, and been practised in the Ordnance Survey Office, viz., ruling a plate all over carefully and taking duplicates from it, having first scraped from the matrix, after the manner of mezzotint, all the parts where lights are required. This is very applicable to engravings of towns, and probably to hills; to every thing, in fact, where an uniform ground is desirable. It is needless to detail the numerous uses of this valuable art which are daily occurring.

It has also been used for copying scales and divided instruments, which will probably become a source of great economy,—a scale which costs several shillings being produced for a few pence.

Some very perfect casts of fossils were very early made by Mr. William Dalgleish; and while the Geological Survey was under the Ordnance a very elegant application of this power was effected by Captain James, R.E., viz., preserving the rare and unique specimens in the country where they are found, and depositing copies made by this process in other museums. Several very beautiful specimens were prepared under his direction for this purpose.

Description of Plate I.

Fig. 1. Original single cell apparatus.

2. Horizontal decomposing trough detached.

3. Two pairs of plates arranged for quantity.

4. Two pairs of plates arranged for intensity.

5. Pair of battery plates in the electrotype apparatus at the Ordnance Survey Office, Dublin.

Details.

A. Wooden frame for supporting the plates, which rest upon brackets fixed to the inside of the battery cell, at a sufficient distance from the bottom to allow space for the sulphate of zinc to sink below the plates.

B B. Plates of silver platinized.

C. Plate of zinc.

b b. Conductors from the silver plates (negative).

c. Conductor from the zinc plate (positive).

d. Connecting piece for joining the negative conductors, through which the positive conductor (*c*) passes.

e e. Conducting wires leading to the decomposing trough.

f f f. Copper bar, with prepared canvas straps for suspending the zinc plate between the silver plates, and keeping them at the proper distance asunder, which is withdrawn when the zinc plate is required to be removed for the purpose of cleaning, and to which is affixed an eye (*g*) for raising the whole frame and plates, when they are to be inserted into the battery cell.

h. Screw, with a similar screw on the opposite side of the frame, for the purpose of pressing the silver plates towards each other as the zinc grows thin.

Description of Plate II.

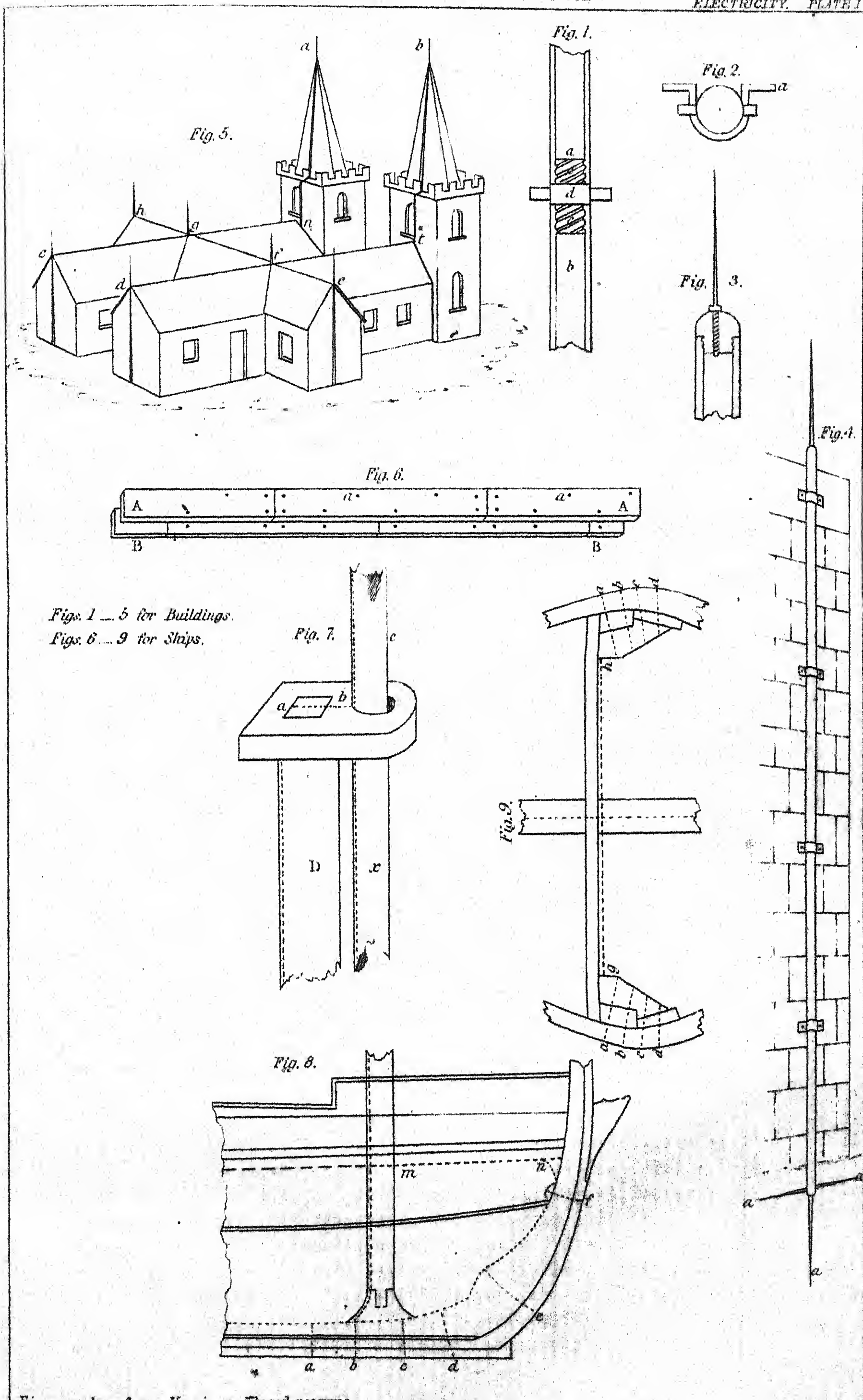
A. The battery cell, extending downwards 2 feet under the floor, and terminating in a point, in which a stop-cock is fixed, to draw off the saturated solution of sulphate of zinc which is formed there. The bottom is reached by a trap-door and steps.

B. The decomposing trough, resting on a keel, which, for the purpose of agitating the solution, enables a rocking motion to be given to the trough, by means of a coupling shaft (*a*) connected with the truck (*b*) on which the trough is moved to any part of the room, for cleaning or changing the plate.

C C. Conductors from the battery plates, each formed of five lengths of copper wire $\frac{1}{10}$th of an inch in diameter, twisted together, and covered with water-proof tape, the one leading to the positive or dissolving plate (*c*), the other to the negative or receiving plate (*d*), the latter being placed on a board, with small feet or wedges, to keep it at the proper distance from, and parallel to, the positive plate.

D. A water-tight box containing a solution of sulphuric acid in the proportion of

LIGHTNING CONDUCTORS.



Figures taken from Harris on Thunderstorms.

C. Ravenberg, sc.

John Weale 59 High Holborn. 1848.

ELECTROTYPE. PL. 1.

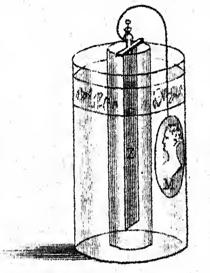


Fig. 1.

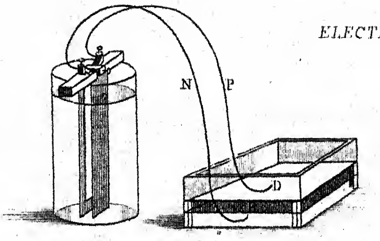


Fig. 2.

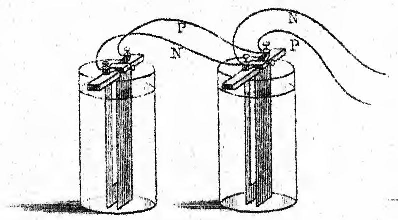


Fig. 3.

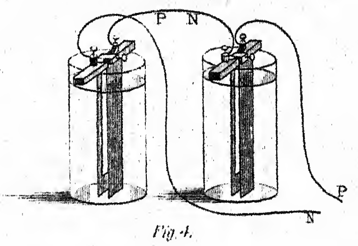


Fig. 4.

Fig. 5.

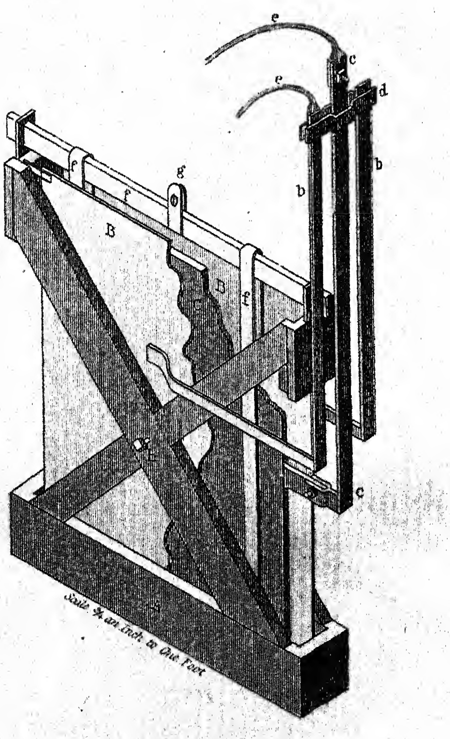
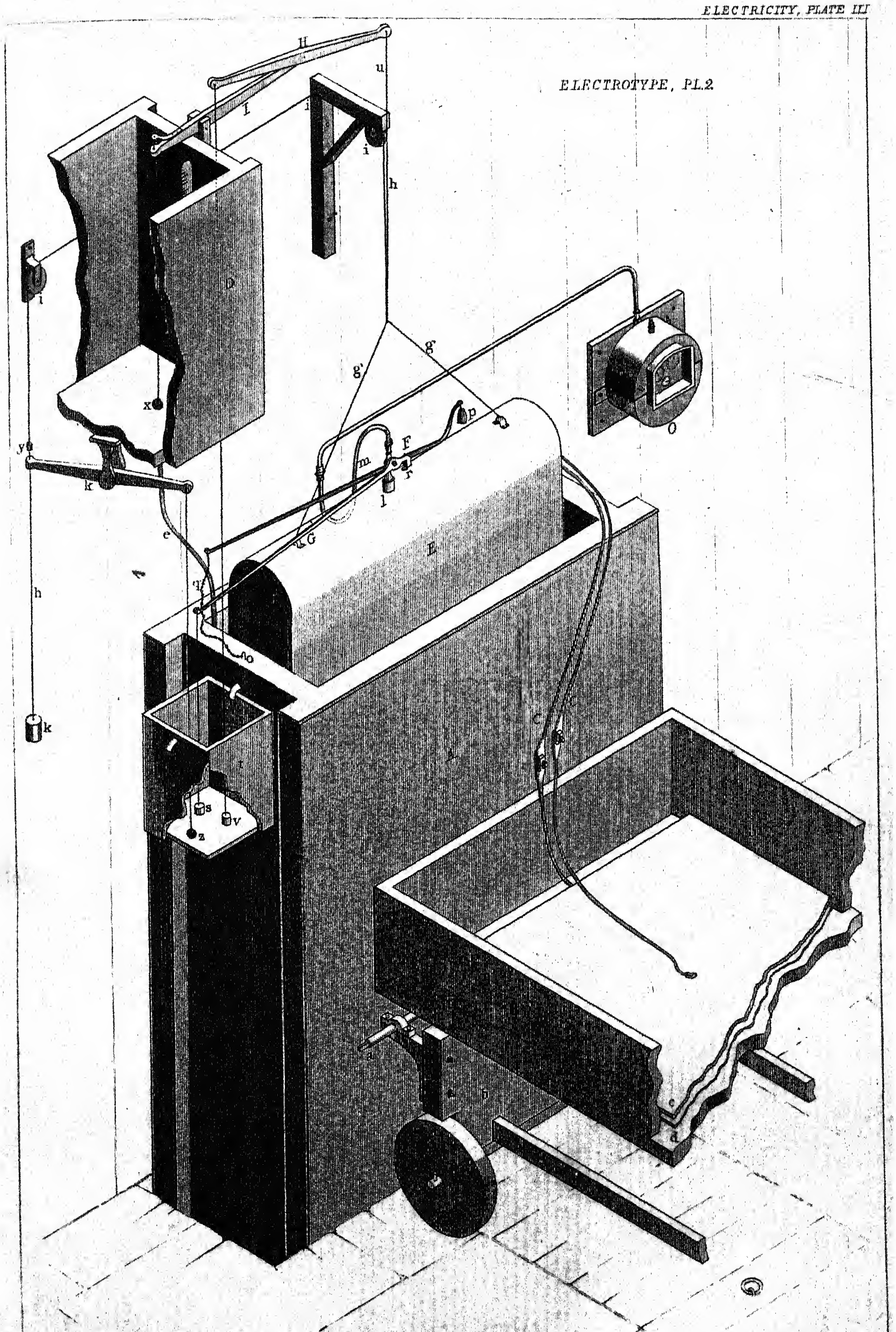


Fig 5 in Isometrical Perspective. Pair of Battery Plates in the Electrotype Apparatus at the Ordnance Survey Office, Dublin.

C. Rosenberg, sc.

John Weale 59, High Holborn 1846.

ELECTROTYPE, PL.2.



Scale _ 3/4 of an Inch to One Foot

W.D.

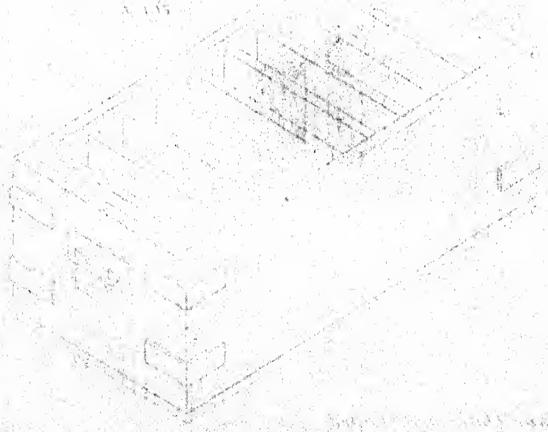
C. Rosenberg, sc.

ONE OF THE BATTERY ARRANGEMENTS

OF THE ELECTROTYPE APPARATUS.

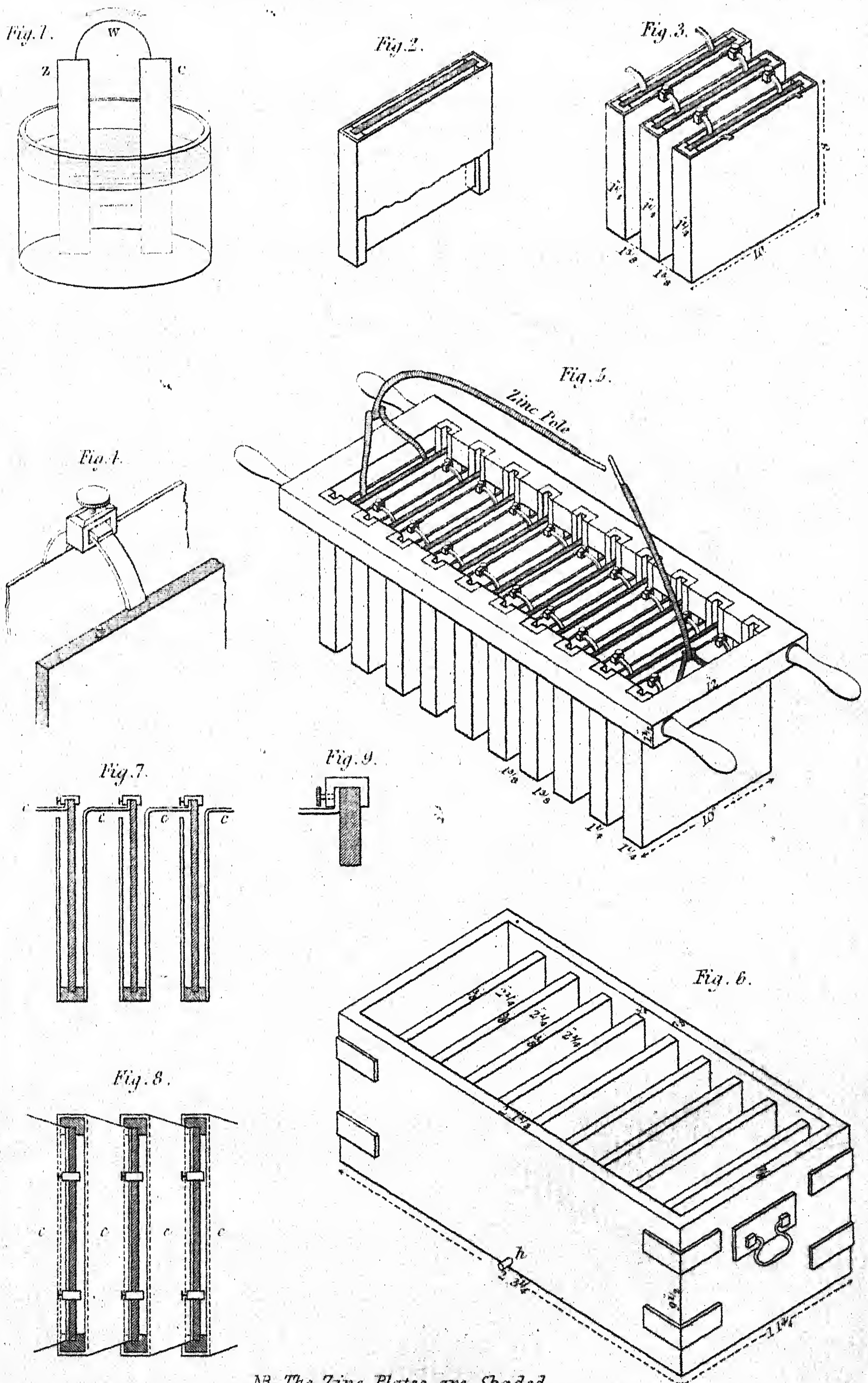
ORDNANCE SURVEY OFFICE, DUBLIN.

John Weale, 59. High Holborn. 1846.



EXPLOSION OF MINES PL. 1.

Details of a Voltaic Zinc & Copper Battery of 10 Cells.



NB. The Zinc Plates are Shaded.

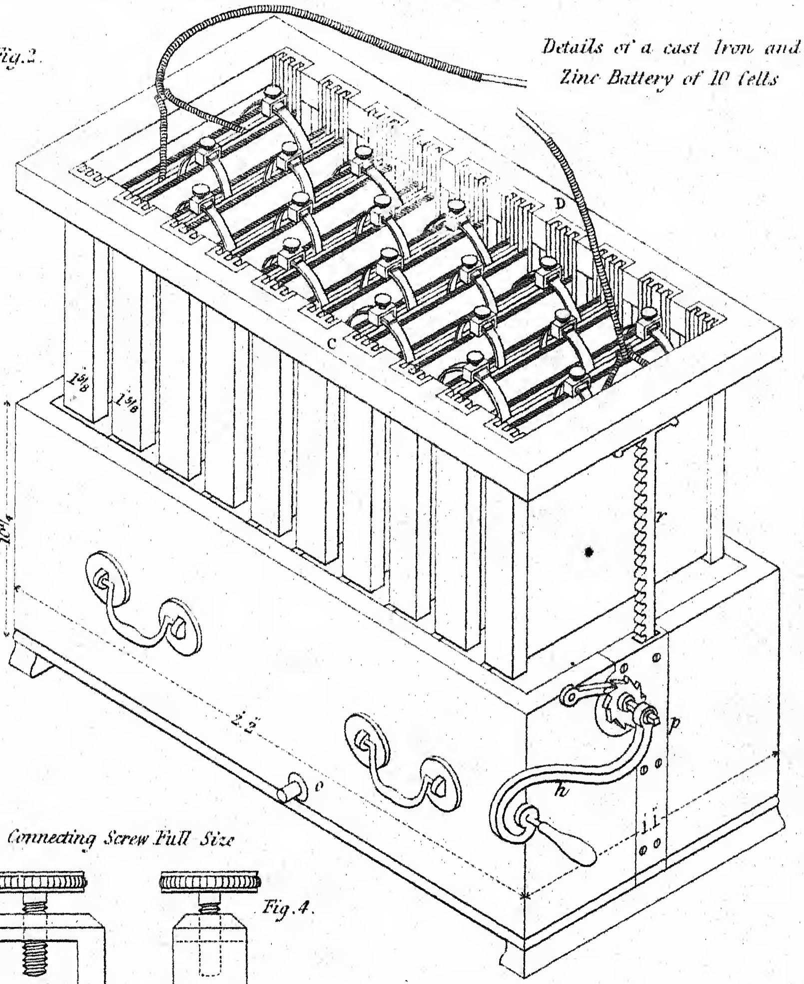
G. R. H. Captⁿ R.E. del. J. W. Lowry fc.

John Weale 59 High Holborn 1846.

EXPLOSION OF MINES, PL. 2.

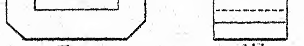
Fig. 2.

Details of a cast Iron and Zinc Battery of 10 Cells



Connecting Screw Full Size

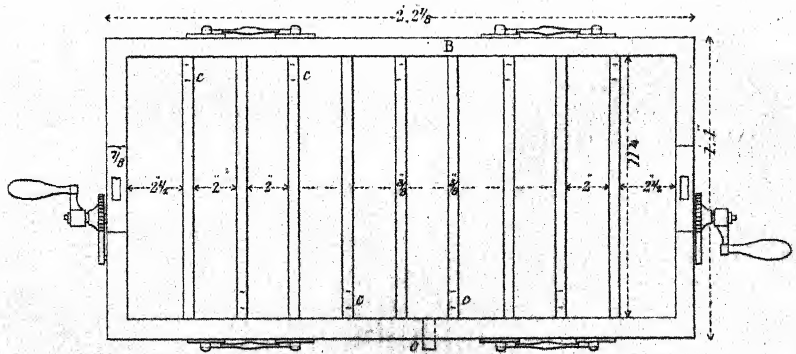
Fig. 3. *Fig. 4.*



Front *Side*

Elevation

Fig. 1.



G.R.H. Capt. R.E. delin. J.W. Lowry fc.

John Weale 59 High Holborn 1846

EXPLOSION OF MINES PL. 3.

Fig. 4.

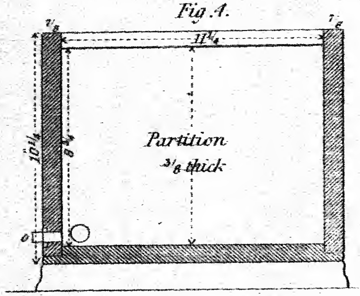


Fig. 5.

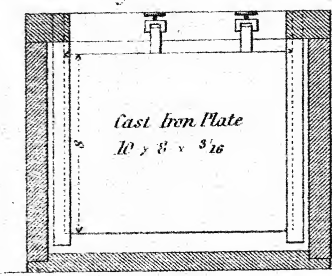


Fig. 1.

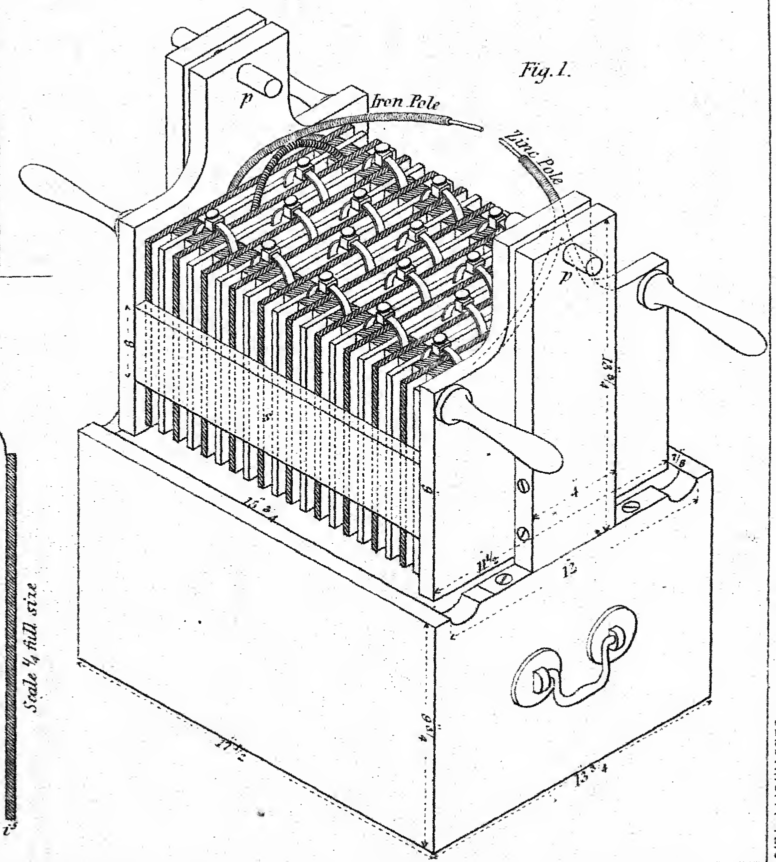
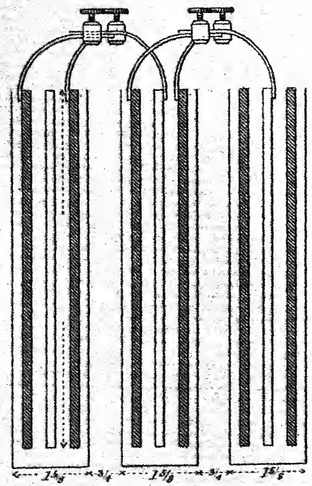


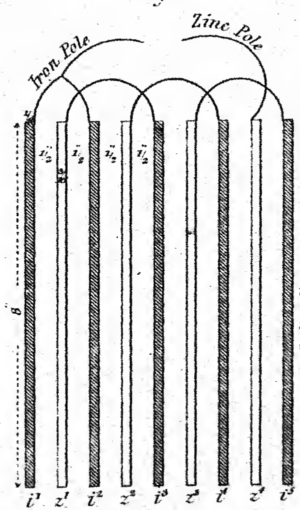
Fig. 3.



Enlarged Section shewing 3 sets of Plates connected

Vide Fig. 2 Fl. Pl. 5

Fig. 2.

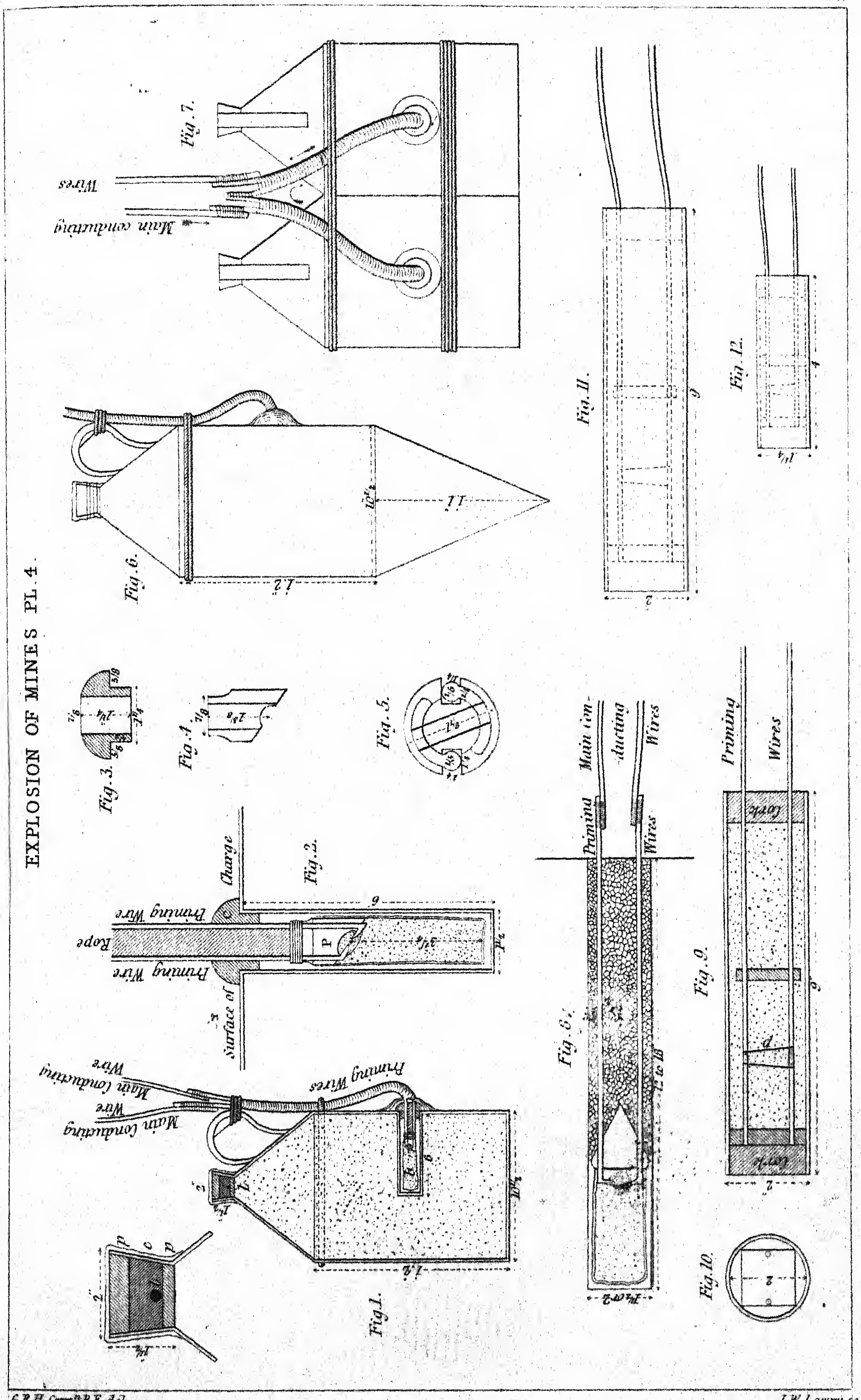


Scale 1/4 full size

G.R.H. Capt.n R.E. del.

J.W. Lowry fc.

John Weale 59 High Holborn 1846.



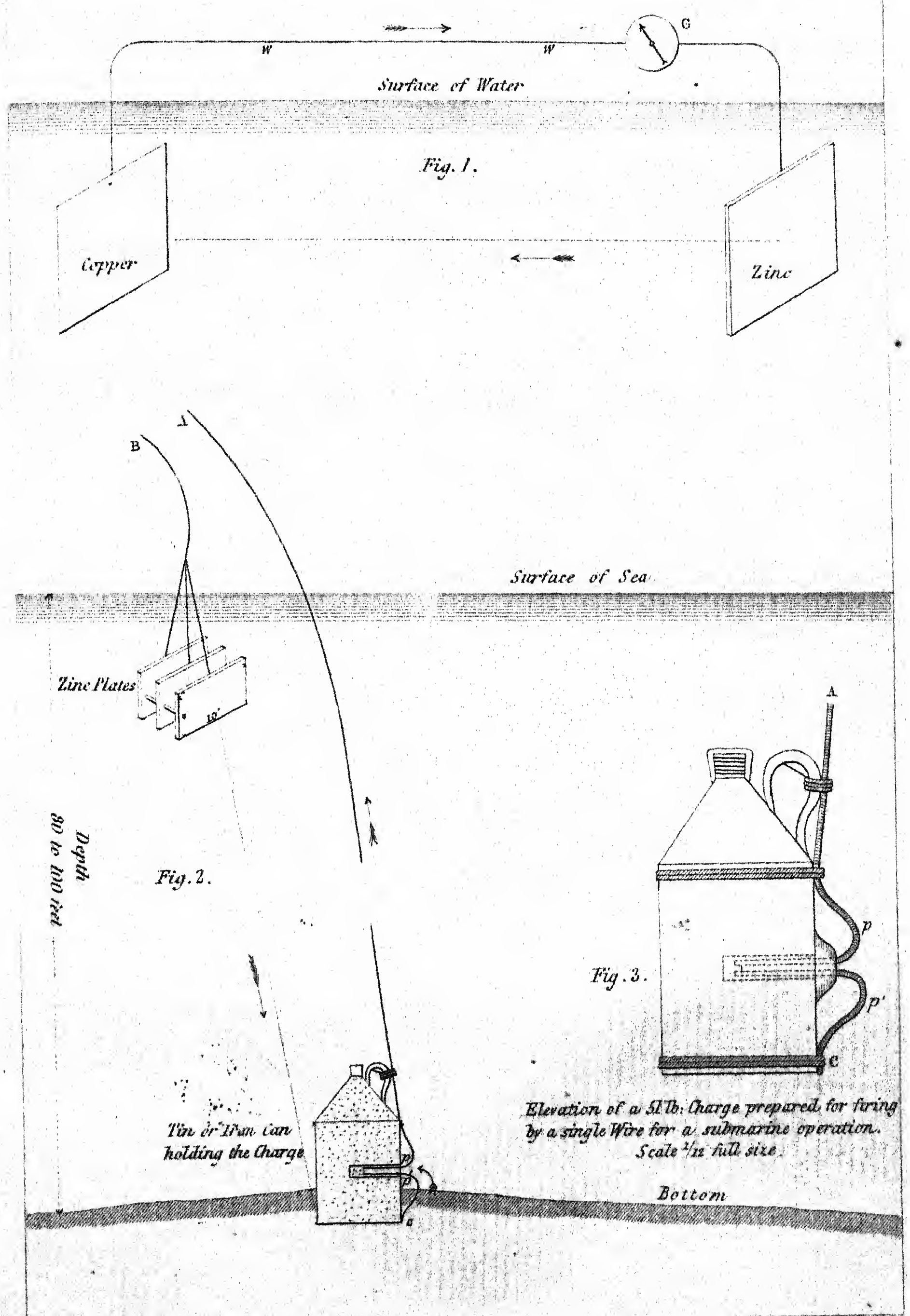
G.R.H. Capt.n R.E. del.

J.W. Lowry sc.

John Weale. 59. High Holborn. 1846.

EXPLOSION OF MINES PL. 5.

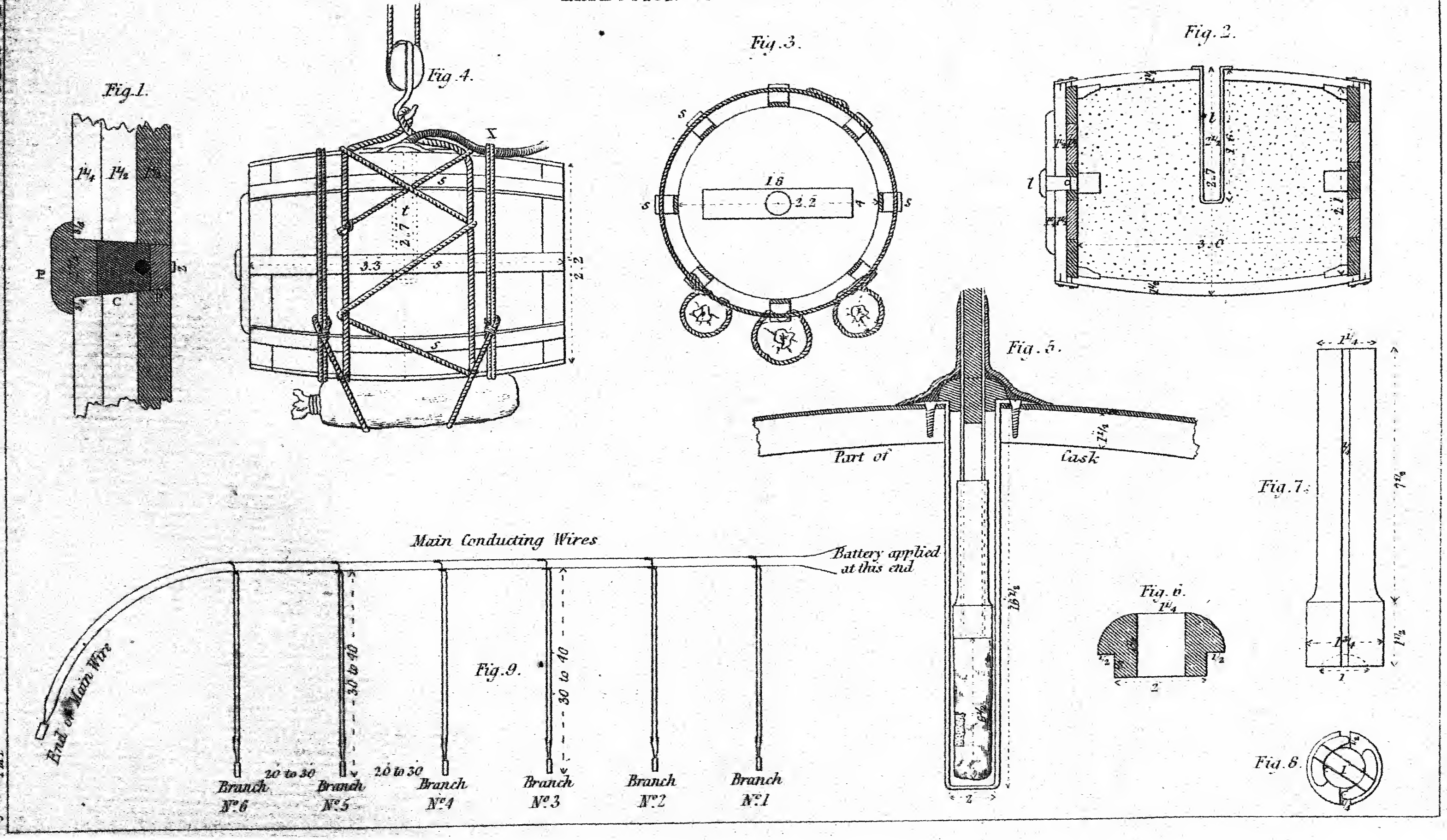
Sketch to illustrate the principle of firing Submarine Charges by a Single Wire.



Elevation of a 51 lb. Charge prepared for firing by a single Wire for a submarine operation.
Scale 1/12 full size.

G.R.H. Captⁿ R.E. del.
J.W. Lowry fc.
John Weale 59 High Holborn 1846.

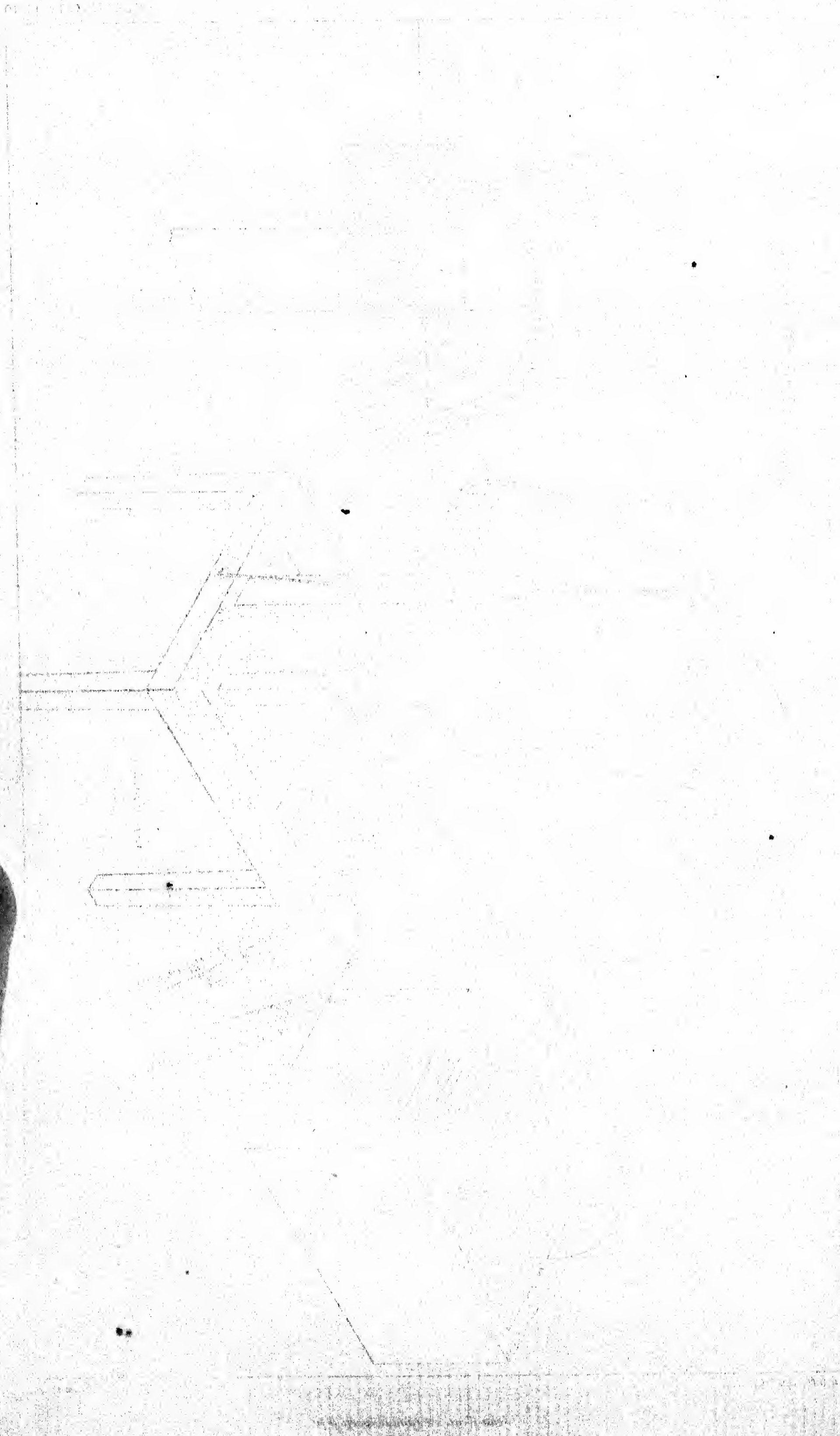
EXPLOSION OF MINES PL. 6.



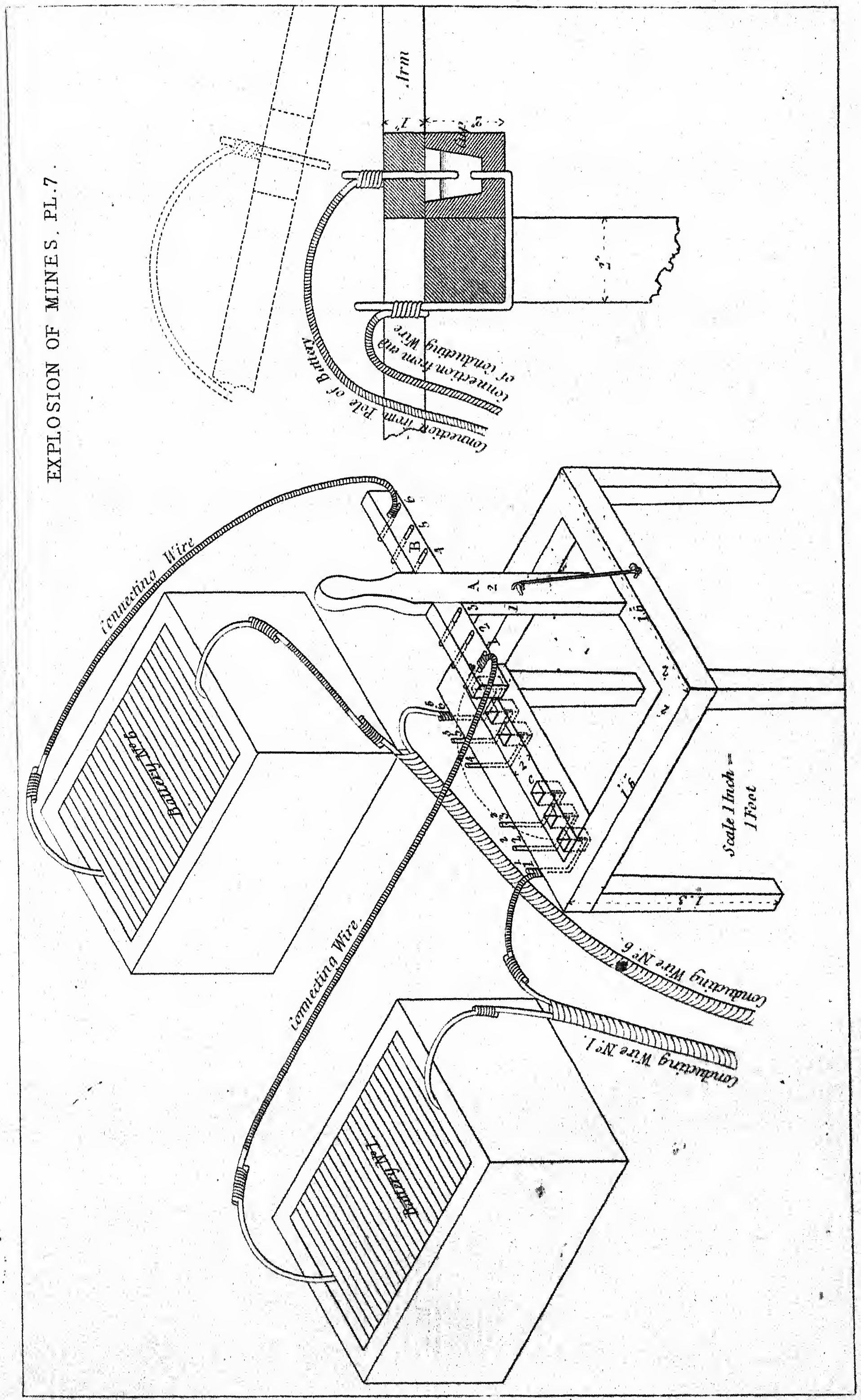
G.R.H. Capt. R.E. del.

J.W. Lowry fc.

John Weale 59 High Holborn 1846.



EXPLOSION OF MINES, PL.7.



G.R.H. Capt^{n} R.E. del.

J.W. Lowry f.

John Weale 59 High Holborn 1846.

EXPLOSION OF MINES PL. 8.

Details of Professor Daniells Cylinder Battery

Fig. 1.

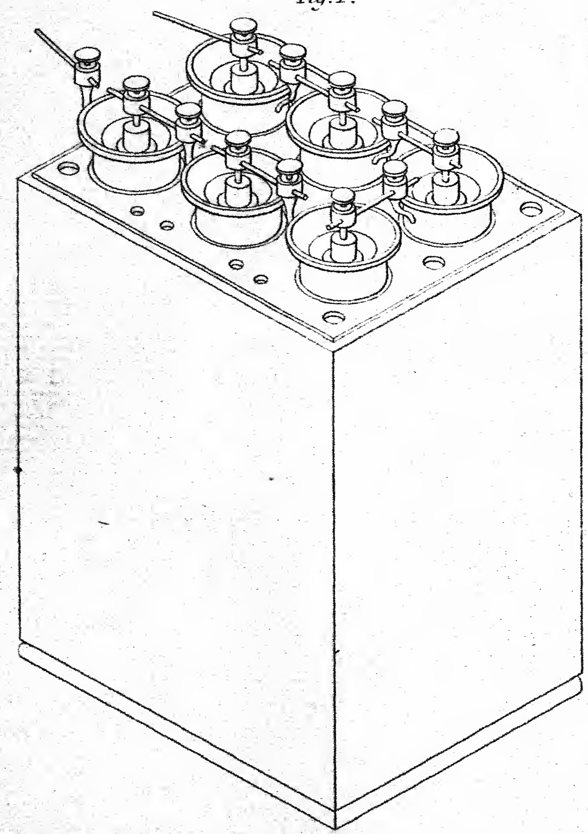


Fig. 2.

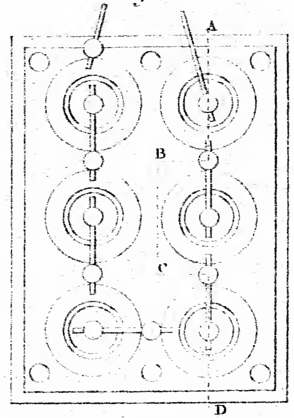


Fig. 3.

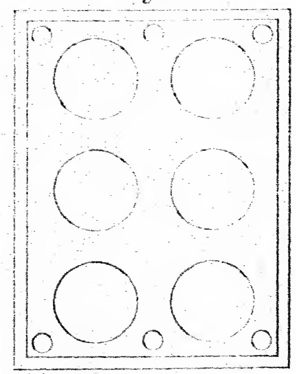
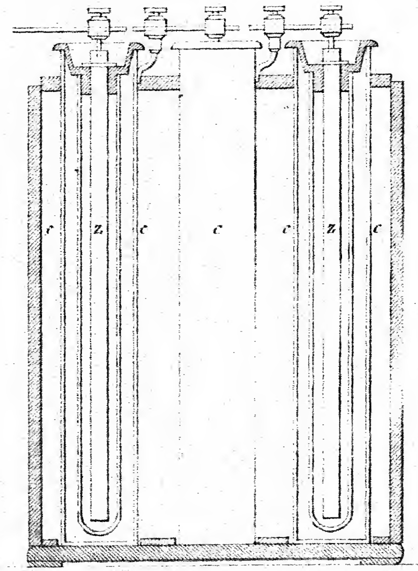


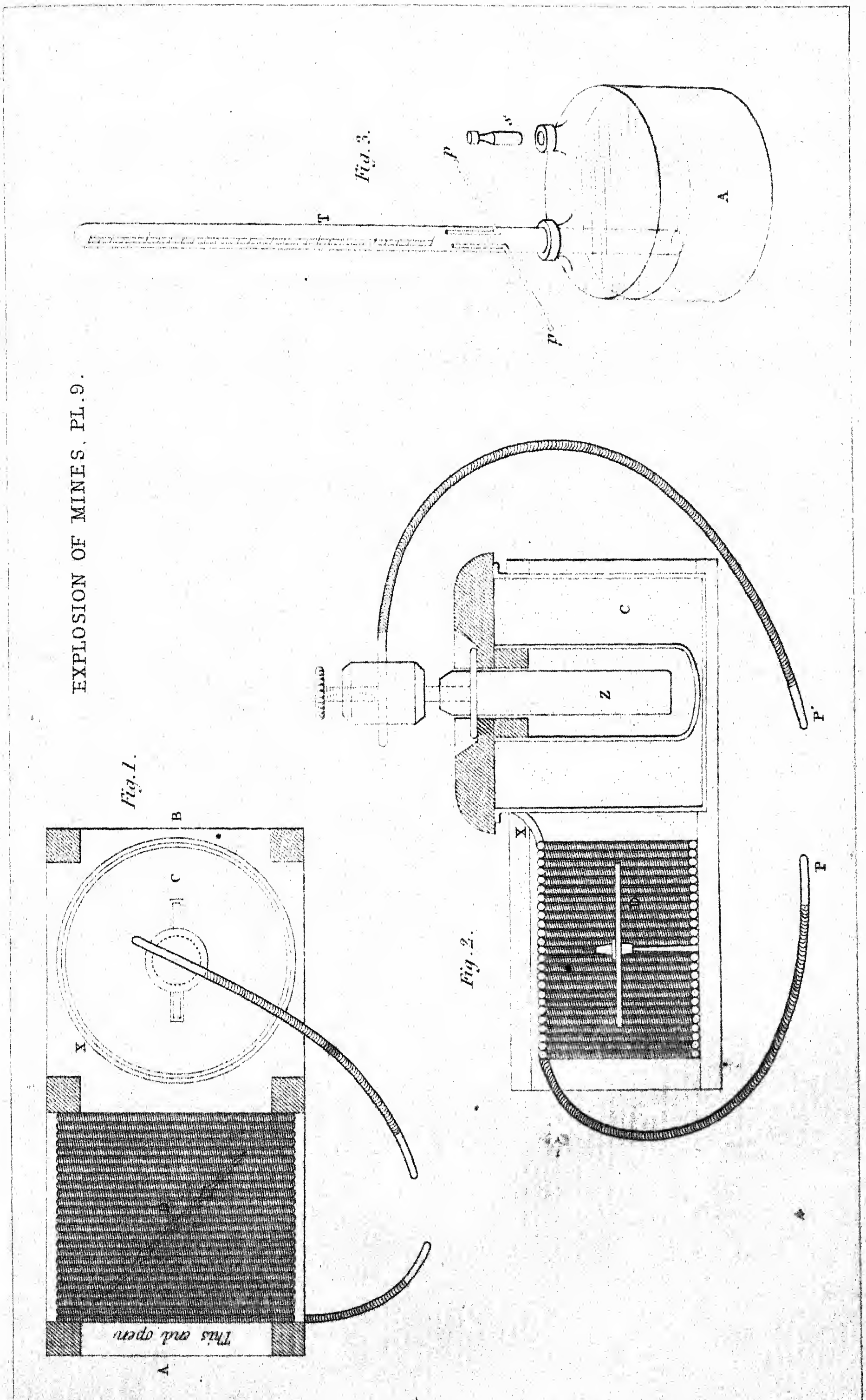
Fig. 4.



G.R.H. Captn R.E. del.

J.W. Lowry sc.

John Weale 59 High Holborn 1846.



EXPLOSION OF MINES, PL. 9.

G. R. H. Capt.ⁿ R. E. del.

J. W. Lowry fc

John Weale. 59. High Holborn 1846.

1 to 4 water, by which the battery cell (having been originally charged with solution of the requisite strength, 1 to 30) is constantly supplied with renewed acid, through a lead pipe (*e*) which extends downwards into the cell about 2 feet, and is turned horizontally so as to cause a circulating movement in the solution. The box is provided with a float (*f*) to indicate the height of the acid solution in it, and the quantity which has passed into the battery.

N. B. In this Plate the acid box is placed near the battery cell for the sake of bringing it within the margin lines. It is nearly close to the ceiling, in reality, so as to afford by its height a considerable force to the solution issuing from the pipe, that it may circulate freely around the battery plates.

For want of height in this Plate, it has also been necessary to omit a beam which passes along the side of the room nearly close to the ceiling, on which a small carriage and pulley travel, for the purpose of raising the plates and moving them to any part of the battery range.

E. A gasometer, or gas collector, formed of thin copper, suspended by the wires (*g*) and the cord (*h*) which passes over the pulleys (*i i i*), and terminates in a counterpoise (*k*), intended to balance in part the collector, which is placed immediately over the plates in the battery, and dips into the solution. It is furnished with a stop-cock (*l*), through which the gas passes by the flexible tube (*m*) and copper pipe (*n*) to a gas meter (*o*).

F G. Levers, the former (F) being attached to the plug of the stop-cock, having at one end a weight (*p*) and at the other a chain (*q*) fastened to the battery cell; the latter (G) turning in the same centre, and brought by a screw (*r*) at one end into contact with the under part of the former (F), and kept in contact with it by the pressing of the weight (*p*). To its other end a small block of wood (*s*) is attached, dipping into a waste box (*t*), and acting as a weight when the box (*t*) is empty, and as a float when the box is filled by overflow from the battery cell.

H I. Levers drawn downwards by the weight of the collector, with which they are connected by the cord (*u*). The former (H) turns on a pivot at the end of the latter, having at its other end a cord carrying a weight (*v*) which acts in the same manner as *s*; the latter (I) carrying, as before mentioned, the lever (H) at one end, and having at the other end a spring (*w*) screwed to it, from which a wire, passing through the lever, descends to the valve (*x*) for the purpose of raising the valve suddenly, being first closed upon the lever until the adhesion of the valve to its seat is overcome, when the spring returns to its former position with a jerk, carrying up the valve, and opening the aperture at once to its greatest extent.

K. A lever fixed to the bottom of the box (D), having at one end a small hole through which the cord (*h*) passes until checked by a knob (*y*), when the other end of the lever rises and lifts a valve (*z*) in the bottom of the box (*t*).

Working of the Apparatus.

The operation proceeds in the following manner. The aperture of the stop-cock (*l*) must be so adjusted by the screw (*r*) as to allow the gas evolved from the plates of the battery to escape at the same rate as that at which it is generated, allowing a slight excess to resist the uncounterpoised portion of the weight of the collector or its tendency to sink down. Then, when the quantity evolved is greater than can pass through the aperture, the collector will ascend till the lever (F) is restrained by the chain (*q*), when the aperture will be enlarged till equivalent to the quantity evolved. On the contrary, when the quantity evolved is less than that for which the adjustment has been made, the collector will descend and pull down the levers (H and I); the weight (*v*) will resist the end of the lever (H), and the end of the lever (I) carrying

the spring (w) will rise, and with it the valve (x) of the acid cistern, with a jerk; a quantity of the strong acid solution will then rush into the battery cell by the pipe (e), with sufficient force to circulate round the plates, displacing a portion of the lighter or less acid solution, which will run off by the overflow pipe (o) into the box (t), which thus becomes a measure of the quantity of acid thrown into the cell. When the lever (H) then becomes released from the weight of the float (v), the acid valve (x) preponderates, falls into its seat, and stops the supply. At the same time, the lever (G) of the collector is also released by the floating of the weight (z), and the aperture of the stop-cock completely closed by the weight (p). The gas collector in this condition rises rapidly, till the knob (y) comes into contact with the lever (K), when the valve (z) opens, and the solution in the waste box (t) runs into a vessel placed for its reception, where its deficiency of acid is supplied, and it again returned to the cistern (D). The waste box (t) being emptied, the floats (s and v) again descend to the bottom of the box (s), carrying down the lever (G), by which the aperture of the stop-cock is opened, and the apparatus is again in a position to throw in a greater supply of acid, if the energy of the battery is not sufficient to evolve the quantity of hydrogen for which the aperture has been adjusted. Thus the *power* of the battery depends on the stop-cock, whose normal position is adjusted in the first instance to the required openness by the screw (r); and the state *of its working* is ascertained by the quantities of gas which pass through the meter in equal times.

ELECTRIC TELEGRAPH.—See 'VOLTAIC ELECTRICITY.'

ELEPHANT.*—For military purposes, and in modern warfare, it is not probable that the elephant will ever again be met with, except in connection with troops moving in India, and the neighbouring countries in which Indian armies are most likely to be employed, viz., the Punjaub, Burmah, &c. It has never been reduced to subjection and applied to useful purposes in Southern Africa, where it abounds; while its employment, whether for war or otherwise, in the northern part of that continent, appears to have gradually lessened from the period of the Punic Wars, until its use was finally discontinued about the age of the later Roman emperors.†

In general the elephant is employed only as a *beast of burthen;* it is by no means well adapted *for draught.* Its great size and bulk render large and cumbrous waggons or carriages necessary, as well from those causes as for the stowage and conveyance of a load proportionate to its strength; and this, though not very

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* By Captain Hawkins, R. E., embodying Notices from Lieut.-Colonel Colvin, H. E. I. C. Engineers.

† On referring this question to Colonel Hamilton Smith, R.E., that learned writer kindly sent several memoranda of much interest from the early historical records of the military use of the elephant: the following abridged extracts from his letter refer to that animal as formerly used in Northern Africa.

"The elephant was used by Ptolemy Philadelphus, who had 300 or 400 in his service.

"The African elephant appears never to have been so well trained as the Asiatic;—when used by Ptolemy Evergetes, they fled as soon as they became aware of the presence of those of Asia. In Pliny, (Hist. Nat. lib. viii. cap. 9,) we find, 'Indicum Afri pavent, nec contueri audent; nam et major Indicis magnitudo est.'

"The Carthaginians do not appear to have used them before the first Punic War in Sicily; and Scipio's defeat was not improbably hastened by the mohouts of his 64 elephants having been bribed, as these men were of that venal and treacherous race—the Numidians.

"The Romans made a resolution never to make peace with any nation that had elephants."

objectionable in a settled and level country, provided with good roads,* is fatal to its utility in such a manner with an army in the field. Nature, too, appears to have formed the elephant rather for bearing than for dragging weights. Its shoulder is not suitable for a collar, which is the best method of applying the power of a draught animal; and the upright and bulky formation of the leg and shoulder is far better calculated to support a burthen than to allow of the due application of the animal's strength and weight in draught. †

The elephant is most usually employed for the transport of large tents and other articles of equipment, of weight beyond the power, or of size inconvenient to be carried by camels or bullocks. Its load for steady work varies from about 15 to 20 cwt., exclusive of the pad or pack-saddle. With this it travels at the rate of 3 miles an hour, from 16 to 20 miles per diem; but it can perform and bear longer marches for some time without injury. On an emergency, a *riding* elephant can travel at the rate of 5 miles an hour, and will go about 40 miles in a day; but for a continuance, its performance will not much exceed that of the baggage elephant.

The number of elephants accompanying an army in the field will always be relatively small, from their comparative scarcity; and the principal means of transport must depend on the supply of camels, bullocks, &c. The employment of elephants must be ruled entirely by circumstances, and it is difficult to enumerate their many probable uses. From their very great strength, and the *unity* of its application, it may, doubtless, be frequently found advisable to apply them to draught, particularly of artillery, notwithstanding the objections previously urged in this notice. Their power, too, would be constantly and beneficially required for *assisting* in the transport of artillery, heavy carriages, &c., independent of the actual traction. And in this manner siege and heavy guns attached to the armies of Native (Indian) powers are generally accompanied by elephants on the line of march, for the purpose of assisting their progress.

The camel 'knocks up' very quickly on stony ground, and in wet weather on clayey soils. To this the elephant is less liable; and valuable at all times, in such cases it becomes doubly so: as also in rough or mountainous districts, for which the camel is ill-adapted by nature, and in which the smaller animals suffer much from being overloaded or overtasked. In such countries the elephant has also been advantageously used for the *carriage* of light mountain artillery (where it could not be dragged); the gun and carriage being separately secured on the pad.

The average price of baggage elephants is from £40 to £50 each, and of riding elephants from £80 to £120. They become fit for work at about twenty years of age, and with ordinary work and common care can be calculated upon for from twenty to thirty years, and often last for a much longer period.

The average monthly expense of an elephant is about £4, of which from 30 to 36 shillings is for the hire of attendants. Each elephant requires a 'mohout,' or driver, and two attendants to procure forage, &c.: when fodder is purchased, or green forage is not used, one attendant only is necessary in addition to the driver; but this cannot be calculated upon in moving with troops. The daily allowance of food is from 20 lbs.

* Elephants are not much used in Ceylon; but in that island they are applied as much to draught as otherwise, subject to the local advantages alluded to in the text. It is doubtful to the writer of this article if the quantity of work usually performed by them is proportionate to their strength and cost. For application of their weight and strength in heavy floods, see 'Professional Papers,' vol. iii. p. 156.

† Colonel Smith also quotes from Ctesias (and Photius, as also cited by Colonel Todd, in his Rajahstan) an application of the elephant, when suitably trained and harnessed, to overturn gates and 'ramparts:' in this case they were of the largest bulk (the Asiatic elephant rarely exceeds 11 feet in height), and were called by Photius Τειχοκαταλυται.

to 30 lbs. of wheat flour, baked into thick cakes, and about 1 lb. of coarse sugar or molasses; about 1 cwt. of green forage, consisting of branches of the peepul, ficus Indicus, and other trees, or of grasses; or if green food is not given, of the same quantity of rice or other straw. In rice countries the same weight of rice (paddy) is usually given instead of the wheat flour. The allowance varies, as above stated, with the size of the beast and health of the animal, and with the province in which it is employed. An occasional physic or spice (cordial) ball is necessary. Elephants are somewhat delicate in their artificial and domesticated state; they require much care and attention, as well as regular and good supplies of food. They are liable to disease, especially from neglected sores caused by badly fitted pads.

The data for the above notice were obtained from authentic sources, and are founded principally with reference to the employment of elephants in *ordinary* travelling in India. It would appear that with large bodies of troops these useful animals must be looked upon as invaluable *auxiliary*, and not as principal means of transport, being much too costly and too scarce to be made generally available as the latter. In the native armies, the disappearance of the chief's elephant is generally the signal for that of the rest in immediate retreat.

P. S. Some experiments have been made in applying elephants to the draught of light field batteries in India; but they have been considered totally unfitted for such service. If thus used, quite independent of other disadvantages, a single shot might cripple an elephant, and thus virtually disable the gun to which he is attached; while half the usual number of horses or bullocks might be injured without materially interfering with its efficiency in action.

In the newspaper detail of the 'Army of the Sutlej' advancing to Ferozepore, an 'elephant battery of iron 12-pounders' is mentioned; but this, probably, refers to the means of transport of the battery, rather than to the manner in which these pieces would be brought into action, as they must have been position guns.

EMBARKATION.—See 'Disembarkation.'

EMBRASURE.—See Notes on Embrasures, at the end of article 'Loophole.'

ENGINEER, MILITARY.*

Under this head will be comprehended—

1. The Corps of Royal Engineers,
2. The East India Company's Corps of Engineers,
3. The Prussian Corps of Royal Engineers,
4. The Corps du Génie of France,

of which Services only authentic accounts have been obtained of their organization, composition, and duties; but as those of other countries are based upon either of the above, the want is not perhaps of importance.

SECTION I.

1. *The Corps of Royal Engineers, and Corps of Royal Sappers and Miners,* forming one establishment; the former comprising the officers, and the latter the non-commissioned officers and privates. These corps at present constitute about one-sixtieth of the British army or regular forces, exclusive of those in India.

* By Major-General Lewis, C. B., R. E.

2. *Composition.**—The actual strength of the corps in 1852 was six Battalions of Officers, and 21† Companies of Sappers and Miners; besides 7 Officers seconded in employment in the civil branches of Her Majesty's Government, most of whose duties somewhat correspond with those of the Engineers of the Ponts et Chaussées of France.

The strength of the Effective Corps consists of—

Colonel, the Master-General of the Ordnance.

Staff of the Corps,	1 Inspector-General of Fortifications. 1 Assistant Adjutant-General.
Corps of Royal Engineers, 290 Officers in 6 Battalions,	6 Colonels Commandant, 12 Colonels, 30 Lieutenant-Colonels, 48 First Captains, 48 Second Captains, 96 First Lieutenants, 48 Second Lieutenants.‡
Corps of Royal Sappers and Miners,	1 Brigade-Major, 1 Adjutant, 1 Quarter-Master, 2 Serjeant-Majors, 4 Staff Serjeants, 18 Companies, consisting of 1462 Non-Commissioned Officers, Privates, and Buglers. 3 Survey Companies, consisting of 315 ditto ditto.

3. *Distribution.*—The Officers of Engineers (except the Staff) were in 1852 distributed in 22 Home Commands, 20 Foreign Commands; 2nd Captains with 1st, and 2nd Lieutenants attached to the Royal Sappers and Miners; besides several Officers employed on the Topographical Surveys of Great Britain and Ireland. The general distribution of the Companies of Sappers and Miners in 1852 was, 2 at head-quarters in course of instruction, 3 Companies attached to the Topographical department, 2 Companies at home, and the remaining Companies in the Colonies.

4. *Administration.*§—In both Corps, and subject to the Master-General of the Ordnance, this is immediately under a Chief Engineer or Inspector-General of Fortifications, assisted by an Assistant Adjutant-General.

In reference to the Engineers, the term 'Administration' implies organization, distribution, discipline, and the practical part only of education, the theoretical portion having been effected at Woolwich. The first three are disposed of at the Head-Quarter Office in Pall Mall; the fourth and last at the Establishment for Field Instruction at Chatham, where the Junior Officers are instructed in sapping, mining, pontooning, construction of batteries, and siege-works in general, besides practical architecture and astronomy, as well as surveying.

In regard to the Sappers, the 1st, 2nd, and 3rd, as well as instruction in regimental duties, are in the hands of the Brigade-Major of that Corps at Woolwich. When at the Chatham Establishment, the education is completed to the extent of sapping, mining, pontooning, construction of batteries and siege-works,—besides, to a certain extent, practical geometry and geometrical drawing.

The Sapper is at all times equal and liable to all the ordinary duties of an Infantry soldier, besides those of a mechanic in the various duties peculiar to the corps.

* It is difficult to explain what produced this arrangement in a body consisting only of Officers, and why the Battalions and Companies are organized without men: see the Composition of the Corps du Génie of the French Service.

† See Ordnance Estimates, 1852-53.

‡ Provisionally 28 in Ordnance Estimate for 1846-47.

§ Contrary to the Artillery System, which has only one place of instruction, discipline, and concentration.

5. *The Special and Ordinary Duties* of both corps—conjointly or severally—comprise the execution of all military works, such as fortifications, magazines, and storehouses, which are termed 'Ordnance' works; all buildings for the accommodation of the troops, and commissariat buildings,—these are termed 'Barrack;' and this constructive branch of the Engineer Service is under the inspection and direction of the Chief Engineer, as well as under the superior control of the Master-General and Board, who examine all projects and estimates, and finally give instructions for their execution, whether these military works are constructed at home or abroad, if the funds are provided by the British Treasury.

6. *Duties in the Field.*—In the field the Royal Sappers and Miners are either workmen or sub-directors, the latter more especially when employed in the trenches, the construction of batteries and bridges, or as mechanics; and very much of the success of the operation, when thus associated with other troops, depends on their skill and the sufficiency of their numbers.

The duties of an Officer of Engineers are so multifarious that it is scarcely possible to define them. On active service, sometimes he is a Sapper officer, at another a Local Engineer in the construction of works and bridges; at other periods he may be employed in the reconnoissance of a country, or attached to a General Officer as Engineer of the division of an army. At sieges,* the whole corps in the field is generally absorbed. The distribution of the Engineer Officers with the army in Spain in 1813 † will explain the occupation of the corps in the field, where about forty officers were employed.

5 were at head-quarters, including the Chief Engineer and Staff.
8 attached to divisions of Infantry.
3 with the Pontoon train.
12 with 4 Companies of Sappers.
4 'Ingénieur du Place' repairing fortresses.
5 employed in the Lines of Lisbon.
3 improving navigation of the River Douro.
—
40

The course of duty assigned to the Officers of Engineers on joining the army was usually inversely to the above arrangements, and they commenced in the Lines of Lisbon: the highest distinction was that of being attached to a General Officer ‡ of Division, which was given without reference to his rank, but on his experience with the army in the field. The extraordinary or mixed duties of Engineer Officers are when they are employed in connection with Civil, Naval, Artillery and other Military Officers, on special services, which are of frequent occurrence.

7. *The detail of duties* of the different commands at home and abroad,—sometimes held by a Colonel, or by a Captain, according to the extent and responsibility of the command, assisted by other Officers of Engineers, and a Civil branch of the Engineer Department, well versed in construction of buildings and framing estimates and drawings. The latter branch consists of Clerks and Foremen of Works, appointments which correspond with the Gardes du Génie of the French Service, and like them they are classed according to their services, zeal, and talents. Abroad, in these duties they are assisted by the Sappers and Miners, whose services are there invaluable; § at

* See articles 'Attack of Fortresses' and 'Battery.'

† Exclusive of the army in Catalonia.

‡ To afford professional assistance in reconnoissances, in the passage of rivers, in the attack and defence of posts and villages, destruction of bridges, in the execution of intrenchments prior to an engagement, and occasional assistance as Staff Officers.

§ See last paragraph of this article, extracted from the 'Journal des Sciences Militaires.'

home, where the work is chiefly executed by contract, except in the construction of fortifications, the superintendence is confined to the Clerks and Foremen of Works under the Engineer Officers. The Engineers are not accountants of money or (generally) of stores; they have only to certify to the expenditure of each when the disbursements are made by an Ordnance or Treasury accountant: hence it will be seen that the Department has no interest in any public expenditure, neither does it derive any pecuniary advantage in the execution of public works.

8. *Historical Reminiscences.*—It appears that prior to the Peace of 1763 the duties of Engineers were executed by Officers taken from the army, in the manner in which those for the Staff are now selected, and the operations at the sieges of Louisburg, Belleisle, and Quebec were conducted by Engineers so selected, the Artillery then constructing their own batteries. Between 1759 and the American War, the Engineers were organized into a permanent corps, those Officers who had served as such having the choice of remaining or returning to their Regiments, when the junior ranks were filled up from the Royal Military Academy at Woolwich; but prior to this organization, that military school only furnished candidates for the Royal Artillery.* About the Peace of 1783, the corps was raised to the rank of a Royal Corps, and the uniform changed from red, faced with black velvet, to blue and black, at the suggestion of Charles, third Duke of Richmond, who established a code of regulations for the Ordnance and Engineer Departments, still in existence, and remarkable for their simplicity and arrangement. Consequent upon the war of 1793 and the augmentation of the army, as well as an increase of the Colonies, the corps of Royal Engineers has been gradually increased from two battalions of Officers to six; and the corps of Sappers and Miners, from several Companies of a sedentary corps of Artificers, was in 1812 (when both corps had their uniform again changed to red, faced with blue velvet,) converted into a body of men well versed in the general duties of engineering, sapping, and mining, as well as their peculiar trades of carpenters, masons, and smiths,—a system organized by Lieut.-General Sir C. Pasley, who had the direction of the practical instruction at Chatham for about thirty years.

9. *Conclusion.*—From this brief description of the corps of Royal Engineers and Royal Sappers and Miners, and their several duties and position with the rest of the army, whether sedentary or active, it will be seen that the organization corresponds, as in other Services, with the nature of our military institutions, although † the Ordnance Branch in the British army is a peculiarity difficult to understand, as at variance with the composition of other armies, where the Minister of War is the supreme and controlling head. In comparing the *personnel* of the French and British Engineers, an extraordinary disproportion will be observed between the senior and junior ranks of Officers: in the former the junior Officers are only one-third, in the latter they consist of one-half; an arrangement most injurious to the Service, when rank is essential, from the isolated nature of an Engineer's duties, to give due weight to his position and opinions.

In respect to the Administration of the British Engineer Service, there seems to be a want of progressive and central education at Chatham, after Officers return from abroad, and sufficient means of mutual instruction at that station, where the experience of each may be made generally known; and where a strict scrutiny ‡ should be made as to the health, qualifications, and aptitude for business of every Officer

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* From January, 1770, to December, 1799, the Engineers were chiefly taken from the Artillery as already Commissioned Officers.—*Editors.*

† See the article 'Ordnance.'

‡ See notice on this subject in Section III.—the Prussian Engineer.

after a certain service commensurate with the advantages he has received. But still, however, what is chiefly required is to place the officers or men at an early period in an active and responsible position, when they will become sufficient for our Service after going through the probationary studies they generally receive; but the nature of Colonial and detached service does not always render this possible, and hence the necessity of a re-union at Chatham, or any other head-quarter station, where some Officer of high authority might be the controlling power, similar to the existing Artillery arrangements at Woolwich.

SECTION II.

THE ENGINEERS OF THE HONOURABLE EAST INDIA COMPANY'S SERVICE.*

The Corps of Bengal Engineers originated in the appropriation of Officers from other branches of this Service to the performance of Engineer duties, with such supplies of tools and stores as could be spared from the Artillery Park. In the course of time, Cadets for this Service of the East India Company, in the Ordnance Departments, were received for education at the Royal Military Academy, Woolwich; whilst others were deemed eligible, educated at private establishments, but subjected to examination by the Examining Officers of the Royal Military Academy. These proceeded to India, for the Artillery or Engineer Services generally; and thence the seniors were allowed the option of filling up any existing vacancies in the battalion of Officers, thus forming the Engineer Corps, after having done duty with the Artillery for from 6 to 12 months. Sometimes a further examination took place, and the selection was made by Government, when the Cadets were finally posted. This continued till 1809, when the present Addiscombe Establishment was formed, after which no nominations for training elsewhere were made. From Addiscombe, at first, the Cadets went to India as before, for the Artillery or Engineers; but at the end of a year, the first step in improvement was made in making the selection for the different branches in England, and retaining those appropriated to the Engineers for further instruction in the special duties they would be called on to perform: this was followed by the East India Cadets being admitted to all the benefits of the course of practical instruction at Chatham, and such continues to the present time. In India, the duties expected to be performed by the Engineer Corps of Officers (for a long time there were no men attached to them) are multifarious. In times of peace, they are expected to be competent in every branch of civil engineering, not only theoretically but practically, having often to instruct the artisans in the best mode of performing their work. They are supposed to be able accountants, having often intricate details of accounts to manage, they being always executive officers in charge of all the details of expenditure. They are further supposed to be capable of surveying in any requisite degree that the public service may demand; and, under the name of Garrison or Executive Engineers of Districts, are in charge of all the fortifications and public works generally, including roads, bridges, and irrigation canals, though there are necessarily exceptions, from the relative paucity of officers, compared with the work to be done. In the field, the duties, on the first establishment of the Corps, were performed in the best manner that circumstances permitted, by one or two officers attached to a division, without men. The first step of improvement was the formation of a Corps of Pioneers, officered from the Line; they were a highly useful and gallant body of men, but deficient in the training requisite for engineer soldiers.

* By Lieut.-Colonel Colvin, Bengal Engineers. Given by this Officer as referring exclusively to the Bengal Presidency; but the organization of the Madras and Bombay Engineers is similar.—*Ed.*

At or about the same time, a Miner Company of about 200 men of all classes was recruited from the Native Military Miners of Upper India. They were under very little discipline, with no training beyond their own traditional practice, and, when not in the field, were put under the Staff Officer of the station they might be at. The Officers of Engineers never saw anything of either the Pioneers or Miners, except when they met on field service, and there was, consequently, a good deal of mutual ignorance of each other's mode of proceeding, not favourable to the public service. These considerations led the Indian Government to decide on the commencement of the present system, and the Corps of Sappers and Miners was directed to be organized by Captain R. Tickell, (now Lieut.-General R. Tickell, C.B.,) the Officer in the Corps (then of the strength of 2 Battalions, or 40 Officers) who had the greatest experience in field duties. The old Company of Miners was taken as a nucleus; volunteers were admitted from the Corps of Pioneers, and fresh men were enlisted for this particular Service. They were formed into a regular Corps of 6 or 8 Companies, with a non-commissioned European Staff trained at Chatham, and young Officers of the Corps of Engineers attached to them. The duties and practice of the Corps were conducted on the same system as in the Royal Engineers, and a very efficient Corps of Sappers and Miners formed. This was soon followed by the abolition of the Corps of Pioneers, whose duties devolved upon the new Corps, which became a good deal dispersed about the country, and were employed on work heretofore performed by the Pioneers in times of peace. This has greatly interfered with the very efficient system of practical education commenced; but the Corps has been more and more drawn together again, and is, probably, benefiting by a more extended practice in their most essential branches of training. There still, however, exists the great defect of a want of mutual acquaintance between the Officers of the Corps (now 92 in number, or strength of 4 Battalions) and the men. It is the custom for young Officers, on first reaching India, to be posted to the Corps of Sappers and Miners, with which they do duty for one or two years: this, however, is not universal (a late Order places them for three months with a department at Calcutta, to learn the theory and practice of forming iron bridges and roofs). From the corps they are appointed Assistants in executive departments, in which they continue and rise, and hardly ever return to the Sappers, or see anything of them, or have any practical experience in field duties, except when in the field, when the Engineer Officers nearest at hand are called in, and in camp meet with a detachment of Sappers under their own Officers. They certainly meet with men well trained, accompanied by an efficient non-commissioned European Staff, tending greatly to expedite and simplify all field or siege operations; but it appears an evil, when such care was taken in the formation of the corps, that a batch of Officers were not attached to them, of which a portion should be annually relieved, so bringing the whole corps of Officers in contact with the men, under a practical course of military engineer duties, at least once in eight or ten years, instead of, as now, never after their first outset in the Service.

The general duties of the Corps are presided over by the Chief Engineer quartered in Fort William.* He has, however, little position or power beyond that of being, *ex officio*, a member of the Military Board, to which every Executive Department of the military service in India is subordinate. In the field, the Officers called on for service are nominated to be Principal Field Engineers, Field Engineers, or Assistant Field Engineers. When sufficiently numerous, they are brigaded, with a suitable Staff; but generally the duties are conducted by a Field Engineer, with one or two Assistants. These Officers report direct to the Chief Engineer; but for supplies of tools or stores for working parties beyond what the Sappers may have, they apply to

* In the Bengal Presidency.

the Military Board, through the Officer in charge of the nearest magazine, who is bound to comply with his indents at once, if he can. In Civil duties, the superintendence, not of the Chief Engineer, but of the Military Board, reaches the Executive Officer through the Superintending Engineers of Circles, who have no executive duties, but power to see that all such are duly performed by the Executive Officers and their subordinates. The power of appeal against any decision of a superior exists to the Governor-General in Council, and even to England; but any appeal beyond the Chief Engineer or Military Board is of very rare occurrence. The foregoing remarks apply exclusively to the Corps of Bengal Engineers, and not to those of the Madras or Bombay Presidencies.

In 1826 the strength of the Corps was increased to 3 Battalions, and in 1844 to

4 Colonels,
4 Lieutenant-Colonels,
4 Majors,
20 Captains,
40 First Lieutenants,
20 Second ditto.

The Sappers and Miners, 10 Companies of each—

2 Serjeants, 2 First Corporals, 2 Second ditto, 2 Privates,	European.
1 Subadar, 1 Jemadar, 4 Havildars, 8 Naicks, 2 Buglers, 120 Sepoys,	Native.

SECTION III.

Das Preussische Ingenieur-Corps.*

The Prussian Royal Engineers form one corps, under the command of the Inspector-General of Fortifications.

It is divided into two parts.

A. Engineer Officers.

For the construction of Fortifications and Military Buildings, who also in time of war take the field; and in war or peace are liable to regimental duty with Sappers. As all these Officers are available for any of the above duties, they must be qualified accordingly.

B. Sappers.

Non-commissioned officers and privates of Sappers. Their duties are—sapping, mining, and pontooning. They are commanded by Engineer Officers who are temporarily attached to them.

The Officers who in peace are charged with fortifications and military buildings are, together with their respective fortresses and garrisons, told off into six Fortification-Inspections or districts, each under an Inspector of Fortifications, whose responsibility extends to *personnel* as well as *matériel*, and who has the rank and pay of the Colonel of a regiment. Every station has its Commanding Engineer,† either a

* Communicated by two German Officers of rank, and translated by Captain Nelson, R. E., with the exception of the last four paragraphs, which, with a few very trivial modifications, are given verbatim from the MS.

† 'Platz-Ingenieur.' There are several terms in the German which cannot be literally translated with accuracy: hence, in the following pages, 'Sappers and Miners' has been substituted for

Major or a Captain, and one or more other Officers, Captains, or Subalterns, according to circumstances.

In war time a proportion of these Officers is transferred to the army in the field.

The Sappers are divided into nine divisions of two companies each, each division forming the proportion for one of the nine * corps d'armée.

Each Company is subdivided into four sections:

1, Miners—2, Sappers—1, Pontooneers.

In time of peace the Sappers of three Divisions (or of three corps d'armée) are under the command of an Inspector of Sappers,—a Staff Officer, who, like the Inspector of Fortifications, has the rank and pay of a Colonel, and who is responsible for the education and training of his men.

Two 'Fortification-Inspections' or districts, and one 'Sapper-Inspection,' together form the charge of a Deputy Inspector-General, who has the rank and pay of a Major-General.† Hence these Officers, combining the control of Engineer and Regimental duties, preside over the three grand divisions of the Prussian Engineer Service.

In time of war these Officers take corresponding command in the field.

According to the necessity of the case, in event of war, the different Sapper divisions are brought to their proper strength by combinations, exchanges, &c.; but they remain under their own regimental Officers, always disposable for Engineer duties, and under the command of the senior Engineer.

Although the Sapper Companies are organized with reference to mining, sapping, and pontooning, yet each section (as detailed above to these duties) receives a specific instruction; and in the execution of any one of these functions the men of the remaining sections act as assistants only. The non-commissioned officers are only occasionally changed from the section in which they have first received instruction or have imparted it to others; the expansion and completion of their education is left to what they can learn at the annual exercises in siege operations, when they act in combination with other troops.

The senior Officers superintend these courses of instruction; the junior Officers (who serve at least three years as regimental subalterns) are in many respects teachers, in others pupils: as the former, they impart such theoretical knowledge as is necessary to the serjeants; as the latter, more especially in their relation to the military service in general, and the technical part of their own more immediate profession in particular.

After going through this complete practical course as a school of application, the young Officer is first transferred to fortification duties; and from thence, on reaching the rank of First Lieutenant, back again to the Sappers to learn the duty of commanding a company: here he remains, as to time, partly on rotation, partly according to the display of greater or less ability, eventually reaching the step of Commander of a Sapper division, who ranks with Chef-de-Bataillon, and also with the Commanding Engineers of Fortresses, in pay and seniority.

The Engineer Staff consists of all those Staff Officers of the corps who either are posted to the higher fortification or regimental commands, or of those who are destined to hold them.

'Pionier;'—the 'Ingenieur-Inspecteur' is our (once!) Deputy Inspector-General; whilst the 'Fortifications-Inspecteur' and 'Pionier-Inspecteur' have been rendered literally, as we have no such functionaries.—*Translator.*

* Undisturbed by the arrangements necessary for Colonies, or for very detached European possessions, a remarkable degree of symmetry has been practicable in the distribution and organization of the Prussian Army; that of the Engineer Corps is of course conformable. For a detailed account of these subjects, see the 'United Service Journal,' Sept., Oct., Dec., 1839.—*Translator.*

† 'Brigade Commandant;'—the word 'Major-General' has various meanings in different Services; it is given above in the English sense, as commanding a Brigade.—*Translator.*

Promotion* to the ranks of Colonel and Major-General is dependent solely on qualification: the Officers who have held regimental appointments will generally have had sufficient acquaintance with fortification duties, and *vice versâ*, to be conversant with the details of these two branches, by the time they reach the rank of Deputy Inspector-General, whose authority extends to both.

Should a First Lieutenant fail in his examination for the rank of Captain, he is transferred to any other branch of the Service for which he may shew particular aptitude.

Suitable qualifications in the different branches of the military service may advance any one in the Prussian Service to the rank of an Officer: though not without example, this is rarer in the Engineers than in other corps; yet when it did occur, it was in times when there was a deficiency in early training in such professional matters as were indispensable, but which in later times is scarcely likely to occur.

First entry and subsequent promotion is, therefore, in time of peace dependent on acquirement; and this principle is continued with that of occasional 'purification.'

In the first instance the candidates bring the same stock of school knowledge as is necessary for other Services; and after a satisfactory examination,—that of Ensign,†—he goes as volunteer to a Sapper Company, where he remains until admissible to the Artillery and Engineer School, though he must previously remain at least a year in the Sapper Company to be well drilled. He repairs to the Artillery and Engineer School with his Ensign's testimonials, and according to his greater or less proficiency and zeal (as well in military subjects as in *Humaniores*), he is either *appointed* Ensign in the course of a year, or is sent back to his Company. At the end of the second year of instruction, if recommended by conduct, and advance in studies, he receives the pay of an Infantry Officer, though this has nothing to do with his rank in the Corps. In this second year also, the Specific Corps Instruction is commenced, and continues until the end of the third year, when, on final examination, he receives his Engineer Commission, and is posted to a Sapper Division as Second Lieutenant.

There exists no especial and printed account on this subject: as embodied in the above, it has been composed from fragmentary notices, and it is only of late that an effort has been made to re-arrange and elaborate the older regulations of the Prussian Corps of Royal Engineers.

PEACE ESTABLISHMENT OF THE PRUSSIAN CORPS OF ROYAL ENGINEERS.

(A.) *The Officer Corps consists of*—

1	Inspector-General of Fortifications, ranking either as General of Infantry or as Lieut.-General.	With 9 Adjutants; 5 of whom are from the strength of the Corps, the rest from the 'Adjutantur.'
3	Deputy Inspector-Generals of Fortification, ranking as Major-Generals or as Colonels.	
6	Inspectors of Fortification.	Ranking as Colonel, Lieut.-Colonel, or Major.
3	Inspectors of Sappers.	
12	Staff Officers.	
36	First Captains,—some of whom are Brevet-Majors.	
42	Second Captains.	
38	First Lieutenants.	
74	Second Lieutenants.	
215	Besides an indefinite number of seconded Second Lieutenants on Infantry pay.	

* An admirable rule *if* it could be worked out fairly: in the Line and Cavalry it is *supposed* to commence with the rank of Major.—*Translator.*

† See 'United Service Journal' for 1839, p. 498.

(B.) *Non-Commissioned Officers and Privates of Sappers.*

9 Divisions (or 18 Companies) of Sappers of 251 men per division, including 1 Accountant.

2 Reserve Companies of 125 men each, including non-commissioned officers.

Those attached to the War Office, those teaching in the Artillery and Engineer School, and those on foreign command, are (with exception of a few) Officers expressly seconded, and chiefly taken from the Staff; as are also the Staff Officers commanding in Fortresses, the Adjutants attached to the Inspector-General and Deputy Inspector-Generals of Fortification, and those to the Divisions of Sappers.

REMARKS.

1st. To meet the demands for Engineers in case of war, the Corps possesses an unlimited resource in the Landwehr Sapper Officers.

2nd. The proportion of Engineers for a fortress of the first class in time of war is about

1 Officer of the Staff,
1 First Captain,
3 Second Captains,
3 First Lieutenants,
4 Second Lieutenants,

and this, as a basis, would be modified according to the size and position of the fortress, with reference to the theatre of war.

3rd. The Conscripts for the Sappers are taken from such mechanical pursuits as are in themselves a preparation for their future military service;—miners, masons, carpenters, sailors and fishermen, rope-makers, smiths, &c., all of them in a proportion fixed for each conscription ballot.

The above-mentioned force (A and B) is the peace establishment: it is composed of the men serving in the standing army a period that lasts five years, including two years reserved furlough. After this period they remain liable to the Landwehr during seven more years, during which they are called in every two years for a drill of fourteen days. The Landwehr, in time of war, doubles the peace establishment.

The Officers of the Landwehr are composed of such as have served in the Engineers for a longer or shorter period, and remain liable to be called in for service in time of war, after having quitted active service to enter some civil branch of the profession. There are now 2 Captains, 6 First and 46 Second Lieutenants, on this footing.

Examinations are to be passed, 1st, before entering the Service as an aspirant; 2nd, in the School; 3rd, before leaving the School; and then before the promotion from First Lieutenant to the rank of Captain. This last examination is more of a practical than of a theoretical character; it is intended to prove that the future Captain has converted *in succum et sanguinem* the different theoretical and practical studies of his profession, and has the experience and judgment to put them in practice.

SECTION IV.

CORPS DU GÉNIE DE FRANCE.*

Organization.—(Order, 13th December, 1829.)

Composition.—The Corps Royal du Génie is composed of—

* Abridged from the 'Aide-Mémoire de l'Ingénieur Militaire,' par Grivet, 1834. Translated by Lieut. De Butts, R. E.

1st. A Staff, including	12 General Officers, 400 Officers of the Staff (24th September, 1831), and Candidates for the Engineers, 9 Professors in the Regimental Schools, 500 Gardes du Génie, 6 Ouvriers d'E'tat.
2nd. The Regimental portion.	3 Regiments of Sappers, 1 Company of Workmen, 1 Company of Veterans (19th November, 1831).

Staff.—The 12 General Officers are—1 Lieutenant-General, President of the Committee of Fortifications; 3 Lieutenant-Generals, members of the Committee; 8 Major-Generals, members of the Committee.

The 400 Staff Officers are composed of (24th September, 1831) 25 Colonels, 25 Lieutenant-Colonels, 72 Majors, 140 First Captains, 138 Second Captains and Lieutenants; Total, 400. These are selected exclusively from among those who have passed through the School of Application.

Every year, the Minister of War (according to the vacancies to be filled up in the Corps) determines what number of pupils from the Polytechnic School ought to be admitted to the School of Application with the rank of Sub-Lieutenant.

After two years of study these Sub-Lieutenants of Engineers undergo final examination. Those who give proof of sufficient knowledge in the necessary acquirements are gazetted in the Corps, according to their rank of merit determined by the examination; they are then appointed to the Regiments of Engineers (or Sappers and Miners) to perform the duties of Second Lieutenants. By this means two-thirds of the vacancies which occur in these regiments are filled up by them.

Such Engineer pupils as, not having been deemed worthy of appointment to the Corps of Engineers after two years of study at the School of Probation, have passed a third year there, take rank with those who leave the same year as they do, and are gazetted according to the degree of merit ascertained by the examination, and they have no right to the rank of Lieutenant before these same pupils. Those who, after their second decisive examination, are found unfit for admission to the Corps of Engineers, are sent away from the school.

Officers of Engineers, besides those admitted to the Corps according to the foregoing qualifications, are liable to be received directly at the School of Probation, until the age of thirty years, after having undergone an examination, the programme of which is determined by the Minister of War.

The Examiner of the Engineer pupils is appointed on the recommendation of the Minister of War.

The Professors in the regimental schools of Engineers are appointed by the Minister of War, proposed by an Inspector-General of Engineers, after having undergone an examination before a Commission presided over by that Inspector.

The Gardes du Génie,* 500 in number, are divided into 3 classes, viz. 120 of the first class, 180 of the second class, 200 of the third class; total 500.

The Minister of War determines the number of these Gardes, from selections made exclusively by the Inspector-Generals of Engineers. They are taken as follows: those of the third class from among non-commissioned officers of the Sappers and Miners who have served at least six years; those of the second class from among the Gardes of the third class, having had at least three years of service in their class; and those of the first class are chosen from the Gardes of the second class who have been two years in the service in their own class.

'Les Ouvriers d'État,' composed of a Governor, a Sub-Governor, and four work-

* Corresponding to the Clerks and Foremen of Works in our Service.—*Ed.*

men, are named by the Minister of War on the conditions prescribed in the warrant of the 24th April, 1822.

Sappers and Miners.—Each of the three Engineer regiments is formed,—1st. Of two battalions, each battalion containing 7 companies of Sappers and 1 of Miners (17th November, 1830). 2ndly. Of an Unattached Company. 3rdly. Of a Waggon Train (28th June, 1832).

In time of war a dépôt is formed of two skeletons of companies from each regiment.

Men intended for the Engineer regiments are required to be strong, of good constitutions, and to be at least 5 feet $6\frac{1}{2}$ inches high (English). They are selected in the following proportions:

$\frac{5}{30}$ from among Carpenters.	$\frac{2}{30}$ from among Smiths.
$\frac{3}{30}$ „ Masons.	$\frac{20}{30}$ „ Excavators.

GENERAL DUTIES OF THE CORPS DU GÉNIE IN TIME OF PEACE.

In time of peace the Officers of Engineers are distributed throughout the interior of France and in the different Colonies.

The following are their particular duties:

1stly. Correspondence and maintenance of the personal relations which exist between Commanding Engineers and the different Civil and Military authorities.

2ndly. Establishment and preservation of the different papers, stores, &c., &c., and those articles which are under the special superintendence of the Engineer of the station; the purchase of the necessary articles, and giving them over for public sale when no longer serviceable.

3rdly. To represent Government, in conjunction with the Military Superintendent, for the acquisition, sales, or cession of ground and military buildings, as well as for fixing boundaries to military properties; to take leases of these properties, to rent others for the service of the State, and to obtain payment for damages done to Government property and to military buildings.

4thly. To superintend everything relating to military buildings.

5thly. To make plans and elevations of fortified places, and the country surrounding them; to report thereon, and on the defence of the neighbouring country; to devise plans for the better protection of such places; to make surveys and military reconnoissances; to draw up reports conjointly with the 'Ingénieurs des Ponts et Chaussées,' relative to works which these last propose to execute along the frontier, and the approval of which depends on a Committee composed of the principal Officers of those two Services.

6thly. To make plans of all military buildings, and records of 'Construction' and 'Occupation.'

7thly. To draw up details and specifications of different works, and carry them into execution when ordered, whether fortifications or military buildings; to estimate for them; and to send the expenditure accounts to the Minister of War, when finished; to draw up at the end of every year projects for works to be executed in that ensuing.

PERSONAL DUTIES.

1. In each station there is a Commanding Engineer, having under his orders one or more Gardes du Génie, or persons in charge of military works, and sometimes officers of a rank inferior to his own. As all the work devolves upon the Commanding Engineer, it is by alluding to him that we intend to describe the different functions and relations of his superiors and inferiors.

2. Commanding Engineers are alone responsible for what is done in the stations where they are placed; their inferiors are responsible to them. Nevertheless, when

projects are made, the Officer who frames and signs them, whatever be his rank, shares with the Commanding Engineer the credit or the responsibility, though the latter approves of them by placing his signature thereto.

3. Commanding Engineers do not correspond direct with the Minister of War. All the documents and plans which relate to their Service are first of all addressed to the District Director of Fortifications, who resides at the head-quarters of the district. This Officer lays them before the Minister, with his own notes and remarks; and the decision of the Minister is made known, through the same channel, to the Commanding Engineers.

4. The Directors of Fortifications have the following especial duties: 1st. To give their advice and experience to Commanding Engineers. 2ndly. To obviate on their own proper authority many of the difficulties which may occur in the execution of the works, and for which the opinion of the Minister would be too slow, or not sufficiently detailed. 3rdly. To inform the Minister precisely of everything which bears a relation to the defence of the frontier. 4thly. To act as an intermediate authority between the Minister and the Commanding Engineers.

5. It follows from the evident importance of the situation of Director of Fortifications, that generally all documents of work proposed in the office of the Commanding Engineer should be made in triplicate—one for the Station, one for the District, and one for the Minister.

6. The Director of Fortifications should pay every year at least two visits to the stations in his district: one in the spring, to set the works ordered a-going; and another in the autumn, to witness the execution of them, to check and sign the measurements, and discuss with the Commanding Engineer estimates to be brought forward in the ensuing year. When the works are but few in number or of no great importance, the Directors pay but one yearly visit, in the autumn.

DUTIES OF THE CORPS DU GÉNIE IN TIME OF WAR.

1. When in the field, l'État-Major du Génie is generally composed of a General Officer, who takes the title of 'Commanding Engineer of the Army;' a General Officer, Chief of the Staff; a Superior Officer, Director of the Park; in fact, of a greater or less number of Superior and Inferior Officers, as well as Gardes du Génie, according to the wants of the Service.

2. To every Division of Infantry is attached a Commanding Engineer, of the rank of at least First Captain.

3. If an army be formed to act separately, a Commanding Engineer is attached to it (who may only be a 'Superior Officer'), or Chief of the Staff, and a Chief of the Park (if there be one), who may be only Captain.

4. The Engineers attached to the army are employed on works of permanent fortification, on those for the attack or defence of a place, and on those of such reconnoissances as are entailed by such works.

5. They may also be required to construct the field-works which the Generals of the Army or of the Divisions may think fit to establish, such as attacks and approaches, redoubts, small forts, blockhouses, têtes-de-pont, intrenched lines and camps, dykes, &c.; also works on the march, such as opening communications, the construction or demolition of roads, bridges, &c., &c.

6. General Officers and Officers of all ranks in the Engineers, who are not attached to a company, form part of the Staff of the Army, of the Corps d'Armée, or of the Division to which they are attached.

7. Every Commanding Engineer receives direct, or through the Chief of the Staff, the orders of the General Officer to whom he is attached; he informs this General of the orders given to him by the General Officers of his own Corps.

8. When it is necessary to establish permanent garrisons in places, or military posts, either conquered or formed by the army, the Engineer Service takes in these places or posts the same duties as at home stations.

9. Officers of Engineers are forbidden to communicate to any other person, except to the General of the Army, or to the General Officer to whom they are attached, or his Chief of the Staff, the state of the supplies, &c., or the plans of places, or of works executed or in execution.

10. The composition of all armies is that of Divisions. This principle of several divisions under one Commander composes either an army, a wing, or a centre of an army, or a reserve. The division is generally formed of two or three brigades, either of infantry or of cavalry; it includes troops of different services in the proper proportion.

TROUPES DU GÉNIE.*

Les troupes du génie sont composées de sapeurs et de mineurs. Elles ont généralement pour destination d'exécuter toutes les constructions nécessaires pendant la guerre; de rétablir les fortifications de toute nature, tant sur les postes isolés, que sur les principaux débouchés et dans l'intérieur du pays; de détruire tous les ouvrages de cette nature appartenant à l'ennemi, lorsque cette destruction n'a pu s'effectuer entièrement par le feu de l'artillerie; de réparer ou de construire les ponts fixes, les digues et les routes ou autres moyens de communication; de les détruire s'ils nous sont nuisibles. Les troupes du génie doivent donc aider à détruire tous les obstacles naturels ou artificiels qui servent à la défense, ou à les construire s'ils deviennent nécessaires. Les soldats du génie sont par conséquent plutôt des ouvriers que des combattants, et ils ne portent des armes que pour leur défense personnelle; car pendant leurs travaux, ils sont protégés par d'autres troupes. Cependant, ce serait commettre une grande injustice, que de ne pas placer cette classe si estimable de soldats au même rang que les grenadiers, les cuirassiers et les canonniers; car il ne suffit pas que les troupes du génie exécutent avec adresse et célérité les travaux qui leur sont ordonnés; mais elles sont presque toujours obligées de le faire dans des circonstances difficiles, et même sous le feu de l'ennemi; ce qui exige un grand sang-froid et une intrépidité égale à celle qu'on peut désirer des autres soldats.

ENGINEER, CIVIL.

SECTION I.

ENGINEER, CIVIL, GENERALLY.†

This profession may almost be said to have originated in England within the last century. Before the middle of the last century, whenever the prospect of great profit induced individuals or bodies corporate to undertake extensive systems of drainage, and for this purpose to call for the assistance of an engineer, recourse was generally had to those great masters of hydraulic engineering, the Dutch. True it is that some solitary exceptions have occasionally been found; men who, like Sir Hugh Myddleton, combined a speculative turn of mind with some mechanical knowledge, and to these two qualities added an untiring energy of purpose leading them to persevere in any undertaking, even under the most discouraging circumstances. But these men were rare instances of a peculiar talent, which, though it thus displayed itself occasionally, was far too uncommon a gift to allow the possessors

* From No. 73, third series, of the 'Journal des Sciences Militaires,' p. 99.
† By Capt. Sir William Denison, R.E.

of it to form a class or profession. The case is very different now: a demand for this peculiar talent has been created by the extraordinary development of our system of internal communication, as well as by the application of steam to the purposes of our manufactures; and employment is now found for hundreds where one was sufficient not fifty years ago for the whole business of the country. So great indeed has been the demand, that the profession may be said to be divided into two distinct bodies, viz., those who turn their attention to subjects which come more particularly within the scope of the duty of a Civil Engineer, such as docks, bridges, canals, rail-roads, &c., and those who devote themselves wholly to the manufacture of machinery. The duties which are involved in the practice of these two branches of the profession, though apparently dissimilar in character, are yet founded upon the same general principles; and the acquirements which are necessary to enable the individual of one class to distinguish himself, or even to practise his profession with a moderate chance of success, will be found equally necessary for those of the other class.

These acquirements are partly abstract and theoretical, and partly experimental or practical. A Civil Engineer should, in addition to the knowledge required to fit him as well as others for the active duties of life, have such a knowledge of mathematics as will enable him to investigate as well as to apply the rules laid down by writers on those branches of the mixed sciences to which his attention will most frequently be drawn. He should be well acquainted with the principles of mechanics, hydraulics, and indeed with all the branches of natural philosophy: a certain amount of chemical knowledge will be found very valuable; he should be able to draw neatly, and should understand the principles of projection upon which all engineering drawings are constructed; a general knowledge of the principles of architecture will also be essential. Having acquired the requisite amount of theoretical information, the next step is to gain that practical knowledge which is essential in order to the proper application of this information. The best mode of gaining this experience is to enter into the employment of some eminent man in the profession, in whose office there will be every opportunity offered to the young beginner of witnessing the mode in which the various descriptions of work are carried on. He will there be employed, first as a draftsman, in copying drawings; as he becomes more acquainted with practical details, he will have more responsibility thrown upon him, and be placed in charge of works, at first of small importance, but, by degrees, of those of such magnitude as will require all his theoretical knowledge, and all the practical experience he may have gained, to enable him to carry out the work to the satisfaction of his employers: he should cultivate a habit of observation, and make a point of taking ample notes and sketches of whatever he may see which in any way bears upon his profession. Having thus by degrees acquired a sufficient amount of information to give him a confidence in his own judgment upon any subject which may be submitted to him, and having become known as an active and intelligent agent of others, he will very possibly be called upon to plan and execute a work himself, and then, by degrees, with industry and activity, may work his way upwards in *a profession where merit alone can lead to distinction.*

The course of the man who devotes himself to the machinery branch of the profession differs but little, up to a certain point, from that just described: his theoretical acquirements should be the same, but the practical part of his education will commence at the bench, where he will learn the use of all the tools and machinery by working at them with his own hands: he will then be placed in the drawing room, and go through much the same routine of instruction as before described, and will by degrees work his way up to the position of foreman; then, distinguishing himself by a power of applying general principles to particular cases, will shew himself capable of assuming the direction of an establishment for the manufacture of machinery.

SECTION II.

ENGINEER, CIVIL—STEAM-BOAT.*

A Steam-Boat Engineer is a person employed to keep the steam engine or engines of a steam vessel in as efficient a state as possible, and to superintend their working.

He must set the engines to work, regulate their speed, and stop them as may be required. His duties while the engines are at work are various. He must take care that every moving part is properly lubricated; that no steam is allowed to pass through valves or joints that ought to be steam-tight; that no air is permitted to enter into any of the parts of the engine where it is essential that a vacuum should be kept up; and that none of the bolts, or pins or keys, work loose by the vibration, and shift their position, or come out of their places. He must also take care that none of the working parts become overheated by any undue amount of friction, arising from any want of proper lubrication, any excessive tightness, or any other disturbing cause; and if they should become overheated, he must take prompt and energetic measures to remedy the evil, and prevent any serious consequences arising therefrom. He must from time to time carefully observe the effect produced by the gradual wear of the working parts, so that if the truth or accuracy of any of these seems to be materially affected, he may take steps to rectify the defects when lying up in harbour. He must also be careful to observe if the frame of the engine ever begins to move or work in any way, and endeavour to discover the cause, in order that it may be remedied when the engines are at rest. One of the most important of his duties is to take care that the engines are kept clean, and any grit or dirt prevented from getting into the bearings or moving parts: he must wipe away all oil and grease most carefully and completely as soon as they have passed through the bearings, and prevent them from running down the rods or remaining about the engine.

The boiler requires his unremitting and particular attention, in order that the proper supply of steam, neither too much nor too little, may be generated for the engine. To insure this, the management of the fires must be duly attended to, both in the supply of coal in the proper quantities at the proper intervals, and in the periodical clearing of the fires from the earthy matters of the coal, which may have become vitrified in the furnace and formed what are called clinkers. By due attention to the former, the smoke in all well-proportioned boilers may be very greatly abated, and, by due attention to both, the consumption of fuel, when the engines are prevented (by a strong head wind, or by the deep immersion† of the paddle-wheels on the commencement of a long voyage) from making the proper number of strokes, and thus using the proper amount of steam, may be reduced in an equal or greater degree than has taken place in the consumption of steam. The due and constant supply of water to the boiler, to compensate for the constant evaporation of the water in the formation of the steam, must be assiduously attended to. Another of the most important of the duties of a Steam-Boat Engineer, during the time that the engines are at work on a voyage at sea, and the last which we shall mention here, is to attend to the degree to which the water in the boilers may become saturated with salt by the continued evaporation which is going on, and to take care that this saturation is not allowed to be carried to such an extent as that a deposition of the salt and other matters contained in sea water should take place. After the boilers have been in operation for three or four hours in salt water, so

* Communicated by Captain Sir Wm. Denison, in connection with the preceding.

This article, though specifically arranged in reference to steam vessels, nevertheless gives much of the sort of routine that is generally applicable to all steam engines, mill-work, rail-roads, mine-pumps, &c., &c.—*Ed.*

† The avoidance of which is, of course, one great advantage of the system of screw propulsion.—*Ed.*

that the water in them has become brine, he ought to test the strength of it, that is, he ought to ascertain the degree of saturation to which it has reached, and continue this examination periodically, whether the engines are fitted with an apparatus for the continuous discharge of a portion of the brine, to be exchanged for a portion of sea water, or whether this system of exchange is left entirely at his discretion, to be attended to by means of the common blow-off cocks. The best test is the common hydrometer, though the thermometer has hitherto been more commonly applied to this purpose, as the brine is considered to be of a proper strength when it boils under atmospheric pressure at a temperature 2° higher than that at which the common sea water will boil at the same time, under the same circumstances.

Before coming into port, it may occasionally be advantageous to take indicator diagrams, to see whether the action of the valves *continues* to be correct; as we presume that this was ascertained to be the case, and that the completeness and effectiveness of all the parts were ascertained at the first.

The duties of a Steam-Boat Engineer, on arriving in port after a long voyage, are also various, and equally important with those he has to perform when out at sea. Immediately on coming to anchor, it is a good practice to test the tightness of the steam-valves and pistons, by putting them in such a position that it can be seen if they allow any steam to pass when it ought not to do so. If any imperfections in these the most vital parts of the engines are discovered, he must draw out the valves, or lift the cylinder covers, to get at the pistons, and rectify the defects in the best manner that he can with the means within his power. He should also occasionally examine all the interior parts of the engines, and rectify any incipient defects. He must now also rectify any want of truth in the parallel motion or in any of the shafts or working parts caused by wear, and tighten or make good any of the fastenings of the frame if he has found them to be loose, and put to rights any other such defects. Any parts subject to corrosion should be carefully examined, cleaned, and dried, and painted if need be. The water should be blown off out of the boilers as completely as possible, and all ashes and soot thoroughly cleaned out of the furnaces and flues. The furnaces and flues must then be thoroughly examined, and the slightest leak or defect that can be discovered made good: it is especially important in a boiler to stop these defects at the first, as otherwise they spread very rapidly. No pains should be spared to discover any suspected leak of steam on the top of the boiler, as nothing tends more to corrode and destroy a boiler than this. Inside the boilers, any scale that may have been deposited from the brine having been allowed to become too strong must be removed, and the whole thoroughly cleaned out from every part of the boiler, from below as well as from the tops and sides of the furnaces and flues. The take-up, the inside of the steam-chests, and of the roofs of the boilers, which are the parts most subject to corrosion from the interior, should be very carefully examined, and after being duly scraped and cleaned and dried, they should be well painted with two or three coats of red-lead, or done over with some other preservative.

The paddle-wheels should also be thoroughly examined, and any broken floats or hook-bolts replaced by new ones. The whole of the iron-work should be thoroughly scraped and cleaned, and when dry, painted with three coats of red-lead, or done over with black varnish, once every four months at least. When in harbour, especially if lying in a stream or tideway, the wheels ought to be turned round every three or four days, to change the parts exposed to the action of the water, and thus prevent corrosion.

He must now also get his supply of stores made good, so as to be ready for another voyage.

To qualify an Engineer to perform these duties, he should be trained as a mechanic,

and be a fair workman in iron, brass, and wood. He should be able to work not only at the lathe or vice, but also at a smith's forge. His education should be such as to make him able to keep accounts, and make notes in his log of all that occurs in the engine-room. He should have sufficient knowledge of mechanical drawing to enable him, in the event of any important part of the engines being broken when at a distance from any manufactory, to make such a drawing of it as would enable a manufacturer to replace it. He should have some knowledge of the first principles of mechanics, a general knowledge of the leading principles of hydrostatics, hydraulics, and pneumatics, without which he cannot fully understand many of the principles carried on in the engine, and on which its power depends. Some knowledge of heat, of the theory of combustion, of ebullition, and of evaporation, may also be reckoned as almost indispensable; to which should be added, if possible, an acquaintance with the subject of steam, especially as regards its temperature, pressure, and latent heat.

EPAULEMENT.—It is necessary to notice this word, from the confusion which a common misapplication of it is apt to produce. In the true sense of the term, it implies the *shoulders* or returns made at the flanks of batteries, or at the extremities of parallels; whereas it has been erroneously used to signify the parapet or merlon of the embrasures, to which these epaulements are appended.

EPROUVETTE.

GENERAL INSTRUCTIONS RELATIVE TO THE PROOF OF GUNPOWDER WITH GUN AND MORTAR EPROUVETTES.

1. Gun Eprouvettes are to be used at all stations for the proof of gunpowder, either large or fine-grained. The Mortar Eprouvettes are only to be used at Waltham Abbey, Purfleet, Portsmouth, and Devonport.

2. Five rounds of each quantity of powder to be proved is to be the minimum of rounds for proof in Ireland and at Foreign Stations.

3. At Portsmouth and Devonport, five rounds also to be fired; but at Waltham Abbey and Purfleet, where proofs are so frequent, (especially in time of war,) and where the modes of proof are so well understood, three rounds will be sufficient, except in such cases as the Officers of the Department see good reason to extend the number of rounds.

4. The proof of powder in store to be made annually, at the most favourable season of the year. The Reports are to be forwarded to the Director-General of Artillery so as to be received by the end of November each year.

5. As a general principle, the powder in the magazines should be classed in lots of 100 barrels, from 10 of which, taken indiscriminately, the samples for proof should be drawn: these samples are to be well mixed, and the proof to be made from the mixture. Subsequent proofs for the same lot are to be taken from ten other barrels, so that by degrees the whole of the powder in the magazine will be subjected to proof; and, as far as can be, none should be issued but such as has been proved. It is always to be understood that such barrels are to be preferred for proof as, from local circumstances, may be presumed to be in the least good condition.

6. In the event of the samples of the first ten barrels not coming up to the standard, it is clearly to be understood that the remaining 90 barrels are not to be considered equally deficient in strength without further trial.

7. When there are several magazines at any station, a proof is to be made of the powder contained in each, in the proportion of 1-10th, as before explained in No. 5.

8. In addition to the annual proofs, whenever powder is landed or exchanged from ships of war, it is to be proved as soon as received, in order that its strength as well as state may be ascertained.

9. Within the general principles laid down in reference to proofs, the Officer on the spot is at liberty to exercise a discretionary latitude; but the Report is to be specific, shewing clearly what has been done, and is to be accompanied by such remarks as may be deemed proper.

10. Although the proof is to be carried on under the immediate orders of the Commanding Officer of Artillery at the station, who is responsible for the faithful adherence to these regulations, yet the returns of proof, as well as any specific Reports connected with them, which may be made, are to be signed by the respective Officers, who are equally interested with the Commanding Officer of Artillery in the due preservation of the powder.

Memorandum.—The proof of fine-grained powder by firing steel balls into elm boards is to be discontinued, and such powder is to be proved by the gun eprouvette only.

Office of Ordnance, 28*th July*, 1828.

INSTRUCTIONS FOR ADJUSTING AND REGULATING THE HALF-POUNDER GUN EPROUVETTE, FOR ASCERTAINING THE STRENGTH OF POWDER AT THE VARIOUS STATIONS AT HOME AND ABROAD.

1. The frame in which the eprouvette gun is suspended is to be set horizontally in both directions by the plummet attached.

2. The trucks to be scotched, to prevent any motion by the swinging of the gun when fired.

3. Two ounces of the powder to be proved is to be accurately weighed, and then placed in the ladle, which is to be carefully introduced into the eprouvette, and pushed up to the end of the bore; the muzzle is then to be raised until the bore is about 45°, so as to let the charge fall to the bottom.

4. The gun being placed horizontally, and at rest, the index is brought by means of the screw to 0°; the gun is then fired by means of a quick-match placed in the vent, and the arc of vibration noted in degrees and tenths. This being repeated not less than three times at stations at home, and five times at stations in Ireland and abroad, the result will be the average comparative strength, which should be nearly as follows:

	Charge.	
With new large-grained Service powder	2 oz. . .	21°
With large-grained powder, issued, but returned into store, and considered serviceable	2 oz. . .	20° 5′
With fine-grained powder, new	2 oz. . .	26°
With fine-grained powder, returned into store . . .	2 oz. . .	24°

5. In repeating the several rounds of proof, should the zero on the graduated arc not correspond with the index, as in No. 4, the gun is to be moved backward or forward until they do correspond; but the screw of the index is upon no account to be altered after the first round.

6. It is of much consequence to keep the bearing and other parts of the spindle clean and well oiled, so as to produce as uniform a friction as possible; it is there-

fore desirable to make the gun swing for some minutes when in its place, and adjusted for firing, previous to the trial of the powder, that every part may find its proper bearing.

7. The gun ought to be fired immediately after being loaded.

8. The gun is to be regularly sponged after each round; and after every proof of the sample of powder, it is to be well washed out and dried before another sample is proved.

Memorandum.—The tests required for the approval of all new powder, merchants' or otherwise, are the same.

The powder is delivered in lots varying from 82 to 100 barrels; every barrel of each lot is opened for inspection and examination by hand: it must be firm in the grain, not easily reduced to a powder by pressure: it should be as free from dust as possible, which is usually ascertained by taking some from each barrel in a bowl, pouring it again into the barrel, and watching whether the dust rises in any undue quantity. If it passes this test, its specific gravity is tried by weighing it in a cubical box of one foot: it is poured from any barrel of the lot *lightly* into the cube, and it should not weigh less than 55 fbs.

A small quantity is then taken from *each* barrel and mixed as a *firing sample* for the whole lot of 82 or 100 *barrels:* this is fired from 8-inch mortars, with 68 fbs. solid turned balls, with 2-*oz. charges*, at 45°; the average range of which, after 3 rounds, must be within $\frac{1}{20}$th of the *sample powder* made at Waltham Abbey annually for the year: 9 rounds are fired from the Waltham sample; 3 at the commencement of the proof, 3 in the middle, and 3 at the end, which is supposed to meet the changes of the day, atmosphere, &c.

Waltham Sample.

1st.	2nd.	3rd.	Mean.
225	240	212	$225\frac{2}{3}$
246	224	222	$230\frac{2}{3}$
235	220	222	$225\frac{2}{3}$
			682
Average mean			$227\frac{1}{3}$
Deduct $\frac{1}{20}$th .			11
			216 Passing point.

Merchants' Powder.

1st.	2nd.	3rd.	Mean.	
251	232	231	238	Passes.
219	219	206	$214\frac{2}{3}$	Does not pass below $\frac{19}{20}$ths.

The same rule is adopted for fine and large grain.

Royal Laboratory, 14*th July*, 1852.

EQUIPMENT OF ARTILLERY.*

SECTION I.

" Trouver une organization d'unité d'Artillerie (c'est à dire de la batterie) qui renferme implicitement les formes qu'elle effecte dans la guerre de campagne, de montagne, de siége, la défence des places et des côtes."—*Anonymous, in* 20*th vol. of Journal des Sciences Militaires*, 3*rd Series.*

The British Artillery, whether for the Field, Garrisons, Sieges, or the Defence of

* By Major-General Lewis, C.B., R.E.

Fortresses, or Coast Defences, is equipped by the Department under the Director-General of Artillery at Woolwich. (See article 'Artillery,' Section II.)

The simplicity of the arrangement adapted since the peace to the nature of our Service, the avoidance of all specialities, of a train of conductors and mechanics distinct from the artillerymen, is not understood by foreigners, nor is the composition of this Service generally known at home.

Captain Jacobi, of the Prussian Service, in his work on Artillery, states:

"It is difficult to understand the composition of batteries of English artillery, as all is uncertainty and confusion in that Service. There is no positive rule for fixing the number and nature of ordnance, or determining the supply and the composition of the parks and reserves; all is abandoned to the decision of the General-in-Chief commanding the expedition."

It is difficult to disabuse the minds of foreigners, and explain the working of the system adopted for the British artillery, so imperfectly understood in our own Service; hence some pains have been taken here to detail the equipments, and for this purpose Tables have been framed from authentic sources.

It has been before shewn that the *personnel* of the artillery comprises one regiment for the general organization of the whole; that Woolwich is the arsenal, head-quarters, and school of instruction; that the regiment is subdivided into battalions for administrative purposes, and those again into troops and companies; the latter, forming $\frac{7}{8}$ths of the whole force, is available either for the field, garrison, coast defences, or the attack of places.

The company or troop is therefore the unit in the artillery that the battalion is to the infantry, or squadron to the cavalry; the number of companies or troops being increased or diminished for war or peace, or each may be expanded or contracted, whether for garrison or field duties.

The whole scope of instruction is therefore primarily given to perfect this unit, whose destiny is for either or many of the duties which may probably be assigned to it; and after leaving the head-quarters, or school of instruction, the Captain commanding endeavours to keep it perfect for any duties which circumstances may assign to it.

The distribution of the *personnel*, under the arrangement of the Deputy Adjutant-General of Artillery, depends upon the exigency of the service, but the period abroad is regulated to a certain number of years, so that the company (the horse artillery does not serve in the colonies) returns to head-quarters to be recruited, re-instructed, and made conversant with all the improvements which may have occurred in ten or twelve years.

Recurring to the subject *Equipment*, which may be said to be formed on the combination of the *Personnel* and *Matériel*,—the question appears to have been well considered, in 1819, by a Committee of General and Field Officers of Artillery, who entered into the experience of the previous 25 years, and it is probable that their opinion will be the basis for all future artillery equipments, with trifling modifications. The following principles are founded on the opinions of that Committee, with some observations rather to explain the Tables of Equipment, and render the subject familiar to all branches of the Service.

The article* 'Equipment of Artillery' is given under the following heads of *Field Artillery* and *Siege Artillery:* the equipments of artillery for the 'Defence of Fortresses' and 'Defence of Coasts' are explained under their respective heads, as neither of these questions was considered by the Committee, nor any rule established for their equipments in our Service.

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* See Section II., paragraph 2, of article 'Artillery.'

SECTION II.—FIELD ARTILLERY.

1. *Horse Artillery*, explained in Table I., gives the equipment of four descriptions of batteries for that Service: why the Committee took into consideration the probability of 12 or 9-pounder brass guns being adopted does not appear, and they gave no opinion upon the subject, further than remarking that they were not originally proposed when the horse artillery was constituted.

2. But as here suggested, on examining the Tables, it will be seen that, deviating from the original intentions, the heavy equipments lose the first essential of horse artillery,—*mobility*, and its capability of acting with and supporting cavalry, besides diminishing in the application of 12 and 9-pounder guns the supply of ammunition from $\frac{1}{3}$rd to $\frac{1}{4}$th,—a point of great importance to this force, as rapidity of firing and the consequent necessary supply is next to activity of movement. It is considered, then, that the 6-pounder gun and 12-pounder howitzer should be preferred for the equipment of horse artillery.*

3. The Peace Establishment of this force would appear to comprehend everything that is necessary and adapted for an increase to that of War and active Service.

4. *Field Foot Artillery* may be said, as it now exists, to be in a state of transition, and expressly organized for a Peace Establishment. The Tables II. III. and IV. are, however, framed upon a supposed war equipment, as recommended by the Committee of Artillery Officers at the close of the last war.†

5. Table II. explains the equipment of four descriptions of foot artillery field batteries, from the 9-pounder brass to the 3-pounder (both inclusive) of 6 pieces to each battery, or 5 guns and 1 howitzer, which has been deemed the most convenient combination of men, horses, and ammunition, for that armament, as regards economy and management, and is especially adapted to the unit or company upon the War Establishment.

6. The most efficient battery for this force is unquestionably the 9-pounder with the 24-pounder howitzer, when the country permits the use of so heavy a field force; and as mobility is of secondary consideration with foot artillery, and as it is especially organized to act with infantry and support its movements, the *effect* of that artillery is the first essential.

7. Table III. is an equipment of reserve field batteries, or batteries of position, the first comprising four heavy pieces of iron, three 18-pounder guns, and one 8-inch howitzer: this force was organized in the latter campaigns of the Peninsular War for the Attack of Posts, and if associated with the heavy field batteries would make a formidable siege equipment for the Attack of Posts and *Places du moment*. The 12-pounder brass gun and the lately introduced 32-pounder howitzer form a powerful battery of reserve or position, and would at critical periods of actions be of great effect. The 9-pounder brass guns, and 24-pounder howitzers, batteries of reserve, are for *auxiliary* batteries, to be attached or posted to infantry for special purposes, in addition to those acting with the divisions, and forming part of their strength. One, two, or more of these 9-pounder batteries of reserve, placed in battery under favourable circumstances, would effect more than if divided over the field of battle, attached to particular bodies where their services might not be available from the nature of the ground, or too great distance from the important point; but if kept in hand until the decisive moment arrives, as at Waterloo, when

* Notwithstanding so much has been said on this point, the value of horse artillery may be considered undiminished.—*Ed.*

† With some slight modifications in the ammunition to suit present arrangements.—*Ed.*

24 pieces were placed in battery to repel the final effort of the enemy and insure victory, it is then that reserve batteries are essential.

8. Table IV. gives the equipment of very light field-pieces for Colonial and Mountain services: these batteries are insignificant in every way, and only fit to be employed in taking the field against savages or an insurgent force, when the *prestige* of artillery would have every necessary effect. Many circumstances may require their equipment in our Service; therefore their nature is explained in this Table. Mountain artillery, when the whole is carried on the backs of animals on pack-saddles, is extremely difficult of application, and *can only be successfully used in those 'Alpine' countries where the mule and muleteer are trained to this species of transport;* but if men, unaccustomed to mules and the animals to them, attempt to move with mountain artillery, a series of difficulties will arise, which can only be understood by those who have witnessed the operation.

The Plates of article 'Carriage' refer to field artillery equipments; and Tables C. F. of 'Artillery' explain the nature of the ordnance, their weight, and ranges.

SECTION III.—SIEGE ARTILLERY.

Table V. is a detail of a battering train of 100 guns of heavy iron ordnance, in the proportion of guns $\frac{6}{10}$ths and howitzers and mortars $\frac{4}{10}$ths, with 40 small brass mortars. The ammunition provided is 1000 rounds for each 24-pounder gun; 1200 rounds for each 12-pounder gun; 10-inch and 8-inch shells; 600 rounds for each iron mortar and howitzer; and 200 rounds for each brass mortar: this supply is exclusive of case and carcasses. The number of men calculated for this siege equipment, as necessary to give three reliefs and laboratory duties, is 1344, or 15 companies of artillery; and the calculation is based upon the probability of $\frac{3}{4}$ths of the ordnance being brought into play at one time, as follows:

Detail of Three Reliefs.

	Non-commissioned Officers and Men.
Twenty-five 24-pounder guns, at 6 men each	150
Twenty 12-pounder guns, at 5 men each	100
Four 10-inch howitzers, at 6 men each	24
Sixteen 10-inch mortars and 8-inch howitzers, at 5 men each	80
Ten 8-inch mortars, at 4 men each	40
Total, seventy-five pieces of ordnance, requiring	394
	3
Total for three reliefs	1182
For laboratory duties	50
Military conductors	12
Reserve to replace casualties and bring up ammunition	100
Total	1344

In further explanation of Table V., reference is made to the article 'Artillery,' and to the Plates of the article 'Carriage;' from which some judgment may be formed of the immense equipment of carriages and ordnance necessary, as comprised in that Table, for a Siege Equipment of Artillery.

SECTION IV.

ABSTRACT OF A REPORT OF A COMMITTEE OF ARTILLERY OFFICERS ON FIELD ARTILLERY EQUIPMENTS, WITH REMARKS THEREON.

1. These remarks may be deemed an act of supererogation upon the opinions of distinguished persons whose experience embraced a period of fifty years, in the latter half of which, field artillery may be said to have been created and perfected. The substance of the Report (which is printed in italics) is limited to such matter as may be considered instructive and useful to the Service generally.

2. *Composition of Field Batteries.—The equipment to be* 5 *guns and* 1 *howitzer for brass ordnance, and* 3 *guns and* 1 *howitzer for iron.*

3. As no explanation is given why this arrangement has been adopted as a principle, it may be remarked that it can be deviated from when circumstances recommend the change to 8 or 9 pieces for field foot artillery by augmenting the companies from 90 to 120 men, which the permanent complement of 5 Officers seems calculated to command. The horse artillery batteries may be limited to 6 pieces; but when the divisions of infantry are larger, and the country favours a larger proportion of artillery, the question may be whether the field foot batteries should not be in preference 8 pieces, comprising six 9-pounder guns and two 24-pounder howitzers, rather than give to each division two batteries of 6 each, and provide for the difference in batteries of reserve, as adverted to in Section II., paragraph 7.

The supposition of having howitzer batteries of reserve presents this difficulty, or rather objection, that they do not carry any round shot, and are therefore unequal to fulfil all the duties of reserve batteries or batteries of position.

4. *Number of Carriages and Rounds per Gun for Field Batteries.—The latter regulates the former, and the whole composed as follows:*

		Rounds each.	No. of Carriages.
Field Batteries.	*Batteries of* 18-*pr. guns and* 8-*in. howitzers*	*G 180, H 112	23
	,, *of* 12-*pr. guns and* $5\frac{1}{2}$-*in. howitzers*	G 184, H 144	23
	,, *of* 9-*pr. guns and* $5\frac{1}{2}$-*in. howitzers*	G 166, H 144	19
	,, *of* 6-*pr. heavy guns and* $5\frac{1}{2}$-*in. howitzers*	G 230, H 144	19
	,, *of* 6-*pr. light guns and* $4\frac{2}{5}$-*in. howitzers*	G 223, H 236	18
	,, *of* 3-*pr. heavy guns and* $4\frac{2}{5}$-*in. howitzers*	G 316, H 236	17
Colonial	,, *of* 3-*pr. light guns and* $4\frac{2}{5}$-*in. howitzers*	G 154, H 80	12
Mountain	,, *of* 3-*pr. light guns and* $4\frac{2}{5}$-*in. howitzers*	G 116, H 72	4

In addition to the above, it was proposed that a supply for a six months' consumption should be at least four times the above.

5. The arrangement and distribution of ammunition is principally departmental, and exceeds the purposes of this work.

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* G, Gun; H, Howitzer.

6. *Horsing field batteries for foreign service was regulated upon the principle of providing for every*

18-pounder gun and 8-inch howitzer	10 *horses.**
12, 9, *and heavy* 6-*pounder gun, and* 24-*pounder howitzer* .	8 ,,
Light 6-*pounder, heavy* 3-*pounder gun, and* 12-*pr. howitzer*	6 ,,
All four-wheeled carriages belonging to field batteries . .	6 ,,

The reasons given for adopting this arrangement were, that entering on a campaign will not be the guide for horsing batteries, with good roads, stables, and forage; but when the animals are exposed, traversing bad roads with a precarious supply of forage will form the principles to regulate the number, and that by rather over-horsing the lighter carriages attached to each battery, the animals of the gun and ammunition carriages will be kept effective, and the Officer in command prevented the necessity of requiring aid from the infantry, and the artillery movements kept from interfering in obstructing the former.

7. The only observation offered is to draw attention of the General Officers and Staff Officers to the vast supply necessary to a field battery,—of importance in the accommodation and provision for forage.

8. *Drivers.—The Committee assumed the principle that one Company of Artillery, consisting of* 5 *Officers,* 1 *company serjeant,* 2 *other serjeants,* 3 *corporals,* 6 *bombardiers,* 2 *drummers, and* 90 *gunners,*† *was not more than adequate to the service of a* 9-*pounder battery, being that in most general use; and as the* 12-*pounder battery will require a little more, and the light* 6-*pounder battery may be worked with a less proportion, they adhered to the principle of a company per battery; and that the artillery drivers must be kept distinct, as they are liable to separation in emergencies of service; and that therefore the equipment of a field battery will take a few more non-commissioned officers and soldiers than it might require if formed into one body constantly acting together, as in the Service of the Continental Powers, and in our Royal Horse Artillery.*

9. Notwithstanding the opinion thus given upon the previous practical working of a Field Foot Artillery in the British Service, it may be remarked that this arrangement has been subverted, and the present organization of a Company of Artillery is of 'Gunner' and 'Driver,' in which the men are capable of acting in either capacity. This change was probably threefold: 1st, to disembody a defectively organized force; 2nd, experimentally; and 3rd, as a Peace Establishment. It is considered, however, that in the event of a War, a Corps of Drivers, or Field Train, must be re-organized, as a necessary and a useful adjunct to the Artillery; for the former body, the Corps of Drivers, was brave and effective, considering the duty of a driver is more passive than active, and hence requires a greater proportion of determination. Probably in the re-organization of a Corps of Drivers, the Officers of the Royal Artillery would be

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* The Duke of Wellington appeared averse to this very large demand of horses, as inconsistent with the means of almost any country; and latterly, in the French Service, six is the maximum number of horses allowed to Field Artillery, even for 12-pounders and 6-inch howitzers, upon the principle that rapidity of movement cannot in any case be required for those pieces, and that the men should be always on foot.

† The strength at present (Jan., 1853) is

5	Officers,
1	Colour-Serjeant,
4	Serjeants,
4	Corporals,
4	Bombardiers,
120	Gunners and Drivers,
2	Drummers and Trumpeters.
Total . . 140	

attached to them, much in the same way that the Companies of Sappers are officered by the Engineers in our Service; and thus, whether a Driver Officer or Artillery Officer, or by whatever appellation he may be termed, he would take his place in the command of the battery according to his rank. It must be obvious to every one practically acquainted with the Artillery Service that the efficient foot artilleryman or gunner must be disqualified in many respects for a driver; that the one should be tall and powerful, and the other short and compact; and in the enlistment of a large force for a War Establishment, the consideration of being able to recruit from that standard of height sufficient for a driver, whose destiny is exclusively for a field train, is of great importance.

10. *Arms of Artillerymen and Drivers.— The Committee recommend a better description of sword, and that the drivers should be armed.*

11. This is a subject delicate to touch upon, as the Artillery evince a particular dislike to have their batteries encumbered with small arms; nevertheless it is suggested that the carbine should be the arm of the gunner, even with the field batteries; and the facility with which it might be slung on the waggon removes the principal objection. The importance of being able to clear or feel the way in the movements of a battery without the assistance of infantry, and, if attacked by light cavalry, of having the means of intrenching themselves among their waggons, seem strong reasons for adopting the carbine as an arm for foot artillery under all circumstances. It appears as consistent as furnishing the horse artillery with cavalry appointments, on the propriety of which there has been no question.

SECTION V.

ABSTRACT OF OBSERVATIONS WITH REGARD TO THE EQUIPMENT OF A BATTERING TRAIN.

See 'Artillery,' p. 52.

1. *Ordnance.—The proportion fixed on is* 6 *guns to* 4 *heavy mortars and howitzers, which, in the consideration of the Committee, may in general be adhered to with propriety; and they are borne out in this opinion by our principal armaments during the late war, as well as by the more modern French details for equipping Battering Trains.*

2. In the article 'Artillery' of this work, Section V., it has been shewn that in a recent ordinance of the French Army, one-half of a siege equipment is composed of heavy mortars and howitzers.

3. *The Committee likewise recommend, that with every battering equipment there should be a portion of small mortars and howitzers, in the proportion of at least one-third, and their calibre should correspond with the heavy artillery employed.*

See 'Artillery,' p. 58, and 'Fire, Vertical.'

4. This affords an opportunity of again suggesting the introduction of the $6\frac{1}{2}$ brass mortars to correspond with the howitzer lately introduced, and disuse of the $4\frac{2}{5}$, as likewise of the adoption of a pierrier, or stone mortar, of light construction, that can easily be transported to the third parallel, or demi-parallel, and capable of pitching heavy shells a short distance and throwing 1-℔. balls.

5. *The Committee proposed to employ with battering trains iron* 12*-pounders* $8\frac{1}{2}$ *feet long, in the proportion of one-third the number of guns, being, it was conceived, sufficiently powerful for direct fire to dismount the enemy's artillery, as well as for firing en ricochet; and the diminished weight of ammunition is an important advantage attending the employment of this nature, but it is an arrangement that can be admitted only in cases where there is an adequate number of* 24*-pounders; and it would therefore be better with small equipments that all the guns should be of the heavy calibre.*

6. Table V., which accompanied the Report of the Committee, gives one-half 12-pounder guns: however, as the Duke of Wellington was not convinced by the reasoning of the Committee, it may be presumed that piece will not in future form part of a battering equipment; and the economy in ammunition is questionable, from the inferior effect to the 24-pounder gun or 8-inch howitzer, one round of either of the latter being equal to three of the 12-pounder gun.

7. *This equipment has been made on a supposition of the new iron 10-inch and 8-inch howitzers being introduced into the Service in preference to brass, the latter being generally injured by their own fire.*

8. In the assumed equipment for a battering train, in the article 'Artillery,' the 8-inch iron howitzer is recommended in the proportion to guns as 4 is to 6, and the whole to consist of 30 pieces of heavy iron ordnance, and 10 light brass, in order to simplify the armament, and render the formation of equipments more easily adapted to the probable wants of the Service; and instead of that proposed in Table V., to adopt 15 24-pounder guns, 10 8-inch howitzers, 5 10-inch mortars, } Iron.

30 total heavy ordnance.

5 $6\frac{1}{2}$ mortars, 5 $5\frac{1}{2}$ do. } Brass.

10 total light ordnance.

And multiply this as a single unit (or proportion) of 30 heavy pieces for the attack of larger or more considerable fortresses.

9. *Ammunition.—In arranging the proportions of ammunition for all battering equipments, it would be a good principle to establish that they should be of three descriptions.*

	Rounds per gun.
Large, for the siege of a fortress of the first class	1500
Medium, for those of the second class	1000
Small, for the attack of a place or post but slightly fortified, and not requiring a regular attack	500

In reference to this arrangement, it ought to be considered as a fixed principle of equipment in all cases, that the proportion of ammunition required should be of round shot and shells to the full demanded, independent of the requisite quantity of case, spherical case, carcasses, &c. The powder is calculated at the following rates.

For Guns.—The Service charges for the whole number of rounds, including case-shot and spherical case.

10-inch howitzers and mortars, 7 lbs. *each round, including powder for filling.*

8-inch howitzers	6 lbs.	,,	,,	,,
8-inch mortars	4 lbs.	,,	,,	,,
$5\frac{1}{2}$-inch mortars	$1\frac{1}{2}$ lb.	,,	,,	,,
$4\frac{2}{5}$-inch mortars	1 lb.	,,	,,	,,

10. The proposition for the supply of ammunition, stores, &c., &c., by the Committee may be considered as a departmental question, so that any observation here would be superfluous; and as they are classed in Table V. by the Committee, so as to afford a facility of reference, the quantities may be given for that or the equipment as proposed of 30 heavy pieces, and the necessary articles demanded in the latter proportion. The great utility of the Table lies in the enumeration of the vast quantity and description of articles requisite for a siege, which few Officers could provide for without its assistance.

CONCLUDING REMARKS.

Adverting to the original proposition,—that the true unit for the Equipment of the Artillery is the Company,—it is conceived that this has been established in a satisfactory relation to the several duties of this regiment,—whether for field batteries or for garrison duties, defence of places, defence of coasts, or for sieges,—as the transition from one to the other is rendered easy by such an arrangement; and thus the homogeneous character of this Service is preserved: otherwise, special Corps of Artillery must be organized for special duties, which would impair the *general* efficiency of every branch, taking into consideration the necessary employment of a large portion on foreign and colonial duty.

And in the event of a *field train* * of non-commissioned Officers and Drivers being re-organized, the course of instruction in the manège at Woolwich renders the Officers of Artillery fit to command that force when sent to field duties,—the driver corps, like the horses and equipage, being adjuncts to the Company when thus employed, it being evident that the battery is assigned to the Company, and not the Company to the battery,—a distinction that would appear trivial were the different services of the Artillery *special;* but they are not, and the elements are so various, and liable to frequent and sudden changes, that it is of consequence to preserve the perfection of the unit, which at such brief notice may be transferred from a Peace to a War Establishment,—from attack to defence of places, or from garrison to field duties. The object should be to complete the COMPANY as the MODULUS of this Service,—this important branch of a well-equipped army.

The 'Equipment of Rocket Artillery'† is postponed for want of authentic information,

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* The re-organization of a field train seems indispensable, not for batteries alone, but for the multifarious duties which will occur in the movement of ammunition, heavy artillery, pontoon trains, and other equipments essential in taking the field.

† WAR ROCKETS, AS ARTILLERY.

Extracts from 'THE SPIRIT OF MILITARY INSTITUTIONS,' *by* MARSHAL MARMONT, DUKE OF RAGUSA, *the celebrated Aide-de-Camp of* NAPOLEON.—*Chapter* III., *Artillery.*

"The third arm indispensable in war is artillery. Of paramount importance, its efficiency depends on organization, and on the principles on which it is based. * * * In war, artillery has daily been acquiring more importance, not only on account of its augmentation, but also from its increased facility of movement, which enables it to combine its operations *ad infinitum.* But to this power of rapid concentration there is a limit. Not only is the number of guns brought into the field circumscribed in its application by the expense it incurs,—but the embarrassment which the great excess of *matériel* occasions on the march would far exceed any advantage that could be derived from it in action. Experience has demonstrated that the maximum of artillery should be four guns to every thousand men. * * * But Congreve rockets, which have been so successively improved, and which are now directed with much accuracy, form at the present day an artillery that, by the development of which it is susceptible, may become the first arm.

"In fact, when an arm is only composed of projectiles, requiring the auxiliary aid of no machine to project them, and shewing no front to the fire of the enemy's artillery—when by the most simple dispositions such a momentary development can be given to their fire, that the entire front of a regiment is deluged with a shower of balls equal to the fire of a battery of 100 guns—then so powerful will be found these means of destruction that it will be impossible to guard against them by a continued adherence to the existing principles of war. The following is, in my opinion, the manner in which Congreve rockets should be employed. In every regiment, 500 or 600 men should be drilled to the service of this new arm. One or two light waggons would suffice to transport 100 tubes or rests, such as the Austrians have adopted—each of which, served by three or four men, would at command deploy a line of fire which the imagination can scarcely conceive. To such a fire would it be possible to oppose troops *en masse*, or even deployed in several parallel lines? Most assuredly not! But the gain of a battle consists in obliging the enemy to retire: for that purpose he must be attacked, the intervening space between the two armies must be traversed—and to accomplish this with the least possible loss, the arm which possesses the greatest rapidity of action ought in preference to be employed. This duty must, therefore, devolve on cavalry, but it must be trained to a new system

and which may be occasioned by the neophyte state of that arm of the Artillery. Already the rocket carriage (see Plate in the article 'Carriage') has become obsolete.

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of manœuvres, to enable it to face the enemy's fire with the fewest chances of destruction. It should, therefore, be thrown forward in skirmishing order, but prepared to rapidly concentrate and charge at a moment's notice. The part which infantry enacts is here inverted; it becomes but the auxiliary of the rockets, or rather the latter becomes its arm *par excellence,* while the firelocks dwindle down to mere accessories for the purpose of repelling an attack.

"Under this new system the instruction of infantry will be entirely different, and must be divided into two parts—the first, told off for the service of the rockets; the second, to support or act as a rallying point to the former when in immediate contact with the enemy. The proportion of arms as it now exists will undergo a change. More cavalry and less infantry will be required—the former drilled in a special manner. There will be also required, if I may be permitted to use the expression, an *infantry-artillery* for the rocket-service, destined for the occupation of intrenched posts, the defence of fortresses, and the operations of mountain warfare.* But these projectiles acquire a vast importance under a thousand circumstances where guns are perfectly useless. In the mountains it is with the greatest difficulty that a small number of light guns, which produce but inconsiderable effect, can be transported. But the rocket combines extended range with multiplied fire. It may be established everywhere, on the crests of the highest peaks or on the lower plateaux of mountains. In the plains it converts every house into a fortress, and the roof of a village church is rendered at will the platform of a formidable battery. In one word, this invention, such as it now exists, and susceptible as it still is of further elaboration, adapts itself to every variety of circumstance, to every possible combination, and must exercise an immense influence on the destinies of armies.

"If, however, Congreve rockets are served by a special corps, if they are considered purely in the light of artillery, they will be so circumscribed in number, that their effect would be inconsiderable. It is by giving to them an immense development that their extraordinary powers can alone be brought into their fullest operation, and for that purpose they must be made the general arm of an army. Man reflects but little on the nature of things. He is governed by the opinions and decisions of others, moves in a vicious circle of monotonous uniformity, without ever exercising his intelligence on the work of alteration or improvement. Thus it will be long before the power of Congreve rockets will be felt and appreciated. But if, on the outbreak of the first war, a General of distinguished ability views the question in all its bearings—embraces all the consequences that may be derived from it—if he prepares in silence his means to deploy them on the first field of battle, his success will be such that, until the enemy shall employ the same, he will prove irresistible. At the moment of making this grand experiment, the genius of the General-in-Chief will exercise a great ascendancy on the fate of the war.

"But although the calculations of reason and foresight all appear to justify the results I have foretold, still experience alone can incontestably establish the merit of this new invention. There are so many unforeseen events which modify the most prudential foresight, the most seductive prospects, that a man of sense and prudence will not be thoroughly convinced until facts have, in the most absolute manner, realized his hopes. Nevertheless, I must repeat that the probability is so strong, and presents itself in so conclusive a shape, that a skilful General ought, on the outbreak of the first war, to prepare for the employment of this new weapon in the way I have explained, to disconcert and astonish his adversary by its effects. If he alone makes use of it, in all probability he will remain master of the field. If, on the other hand, the enemy should have displayed equal prudence and foresight, he will escape the certainty of becoming his victim. But this vigilance and forethought ought beforehand to embrace not only the immediate employment of this new means, but also all the consequences that may result from it, relatively to the other arms, to their proportions, their manœuvres, and their employments. It is evident that, after the first successful application of the Congreve rocket in a campaign, it will be adopted in all the armies of Europe. An equilibrium will be then established—all exclusive advantage set aside. But the art of war will undergo a singular modification, the moral effect of battles will be greater, their action more decided, and the effusion of blood will be consequently less. For in war it is not the number of men who are killed, but the number who are terrified, which is the guarantee of victory. I therefore again repeat, that Congreve rockets will produce a revolution in the art of war. They will redound to the glory and profit of the General who will the first comprehend their importance and skilfully avail himself of all the advantages to be derived from them."

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* More especially in Canada, where the numerous rivers and lakes render the movements of artillery always difficult, and at times impossible. The carcass-rocket seems particularly applicable to the destruction of blockhouses on isolated points, rendered inaccessible to guns by the surrounding forests, swamps, &c. of an unreclaimed country. See 'Mountain Artillery,' in vol. ii.

TABLE I.

Equipment of Royal Horse Artillery Batteries for Service, for either of the following Brass Ordnance.

Nature of Equipment.	12-pr. Gun and 24-pr. Howitzer Battery.			9-pr. Gun and 24-pr. Howitzer Battery.			Light 6-pr. Gun and 12-pr. Howitzer Battery.			Heavy 3-pr. Gun and 12-pr. Howitzer Battery.			Remarks.
	Gun.	Howitzer.	Total.	Gun.	Howitzer.	Total.	Gun.	Howitzer.	Total.	Gun.	Howitzer.	Total.	
Ordnance.													See Artillery Plates I. & II., and Artillery Tables D. E. and F.
Guns	5		5	5		5	5		5	5		5	
Howitzers . . .		1	1		1	1		1	1		1	1	
Total pieces of Ordnance			6			6			6			6	
Establishment.													
Captains			2			2			2			2	
Subalterns . . .			3			3			3			3	
Staff Serjeants . .			2			2			2			2	
Serjeants			3			3			3			3	
Corporals . . .			3			3			3			3	
Bombardiers . .			8			7			6			6	
Gunners	10	10	96	9	9	90	8	8	80	8	8	80	
Trumpeter . . .			1			1			1			1	
Farrier			1			1			1			1	
Carriage Smith . .			1			1			1			1	
Shoeing „ . .			5			4			3			3	
Collar-makers . .			2			2			2			2	
Wheelers			2			2			1			1	
Drivers, Serjeant .			1			1			1			1	
„ Corporals .			4			4			3			3	
„ Privates .			93			80			69			65	
Medical Officer . .			1			1			1			1	
Total Establishment			228			207			182			178	
Carriages.													
Gun and Howitzer carriages	5	1	6	5	1	6	5	1	6	5	1	6	
Gun and Howitzer spare do.	1		1	1		1	1		1	1		1	
Store waggons . .			2			1			1			1	See Plates of article 'Carriage.'
„ cart . . .			1			1			1			1	
Forge waggon . .			1			1			1			1	
Ammunition waggons	10	2	12	7	2	9	6	2	8	5	2	7	
Total Carriages			23			19			18			17	
Horses.													
Riding			79			78			64			64	This includes spare horses at $\frac{1}{10}$ per battery.
Draught	10	10	160	8	8	135	6	6	115	6	6	108	
Baggage			7			7			7			7	
Total Horses			246			220			186			179	
Ammunition.													
Round	120		600	$121\frac{3}{5}$		608	$172\frac{2}{5}$		863	272		1360	
Case	14	12	82	$19\frac{1}{5}$	12	108	21	12	117	44	12	232	
Spherical do. . .	50	72	322	$25\frac{3}{5}$	72	200	30	118	268		118	118	
Shells		56	56		56	56		98	98		98	98	
Carcasses		4	4		4	4		8	8		8	8	
Total Ammunition			1064			976			1354			1816	

TABLE II.

Equipment of Field Batteries of Royal Foot Artillery for Service, for either of the following Brass Ordnance.

Nature of Equipment.	9-pr. Gun and 24-pr. Howitzer Battery.			Heavy 6-pr. Gun and 24-pr. Howitzer Battery.			Light 6-pr. Gun and 12-pr. Howitzer Battery.			Heavy 3-pr. Gun and 12-pr. Howitzer Battery.			Remarks.
	Gun.	Howitzer.	Total.	Gun.	Howitzer.	Total.	Gun.	Howitzer.	Total.	Gun.	Howitzer.	Total.	
Ordnance.													See Artillery Plates I. & II., and Artillery Tables D. E. and F.
Guns	5		5	5		5	5		5	5		5	
Howitzers		1	1			1		1	1		1	1	
Total pieces of Ordnance			6			6			6			6	
Establishment.													Two men are carried on the gun limbers, and six men on each ammunition waggon. See Plates of the article 'Carriage.'
Captains			2			2			2			2	
Subalterns			3			3			3			3	
Serjeants			3			3			3			3	
Corporals			3			3			3			3	
Bombardiers			6			6			6			6	
Buglers			2			2			2			2	
Gunners			90			90			80			80	
Drivers, Lieutenants			1			1			1			1	
„ Staff Serjeant			1			1			1			1	
„ Serjeants			2			2			2			2	
„ Corporals			5			5			4			4	
„ Bugler			1			1			1			1	
„ Farrier			1			1			1			1	
„ Shoeing Smiths			4			4			3			3	
„ Carriage do.			1			1			1			1	
„ Collar-makers			2			2			2			2	
„ Wheelers			1			1			2			2	
„ Privates			84			81			73			70	
Medical Officer			1			1			1			1	
Total Establishment			213			210			191			188	
Carriages.													See Plates of article 'Carriage.'
Gun and Howitzer } carriages	5	1	6	5	1	6	5	1	6	5	1	6	
Gun and Howitzer } spare do.	1		1			1			1	1		1	
Store waggon			1			1			1			1	
„ cart			1			1			1			1	
Forge waggon			1			1			1			1	
Ammunition do.	7	2	9	6	2	8	6	2	8	5	2	7	
Total Carriages			19			18			18			17	
Horses.													This includes spare horses at $\frac{1}{10}$ per battery.
Riding			19			19			18			18	
Draught			137			131			117			111	
Baggage			8			8			8			8	
Total Horses			164			158			143			137	
Ammunition.													
Round	$121\frac{3}{5}$		608	174		870	$172\frac{3}{5}$		863	272		1360	
Case	$19\frac{1}{5}$	12	108	22	12	122	21	12	117	44	12	232	
Spherical do.	$25\frac{3}{5}$	72	200	34	72	242	30	118	268		118	118	
Shells		56	56		56	56		98	98		98	98	
Carcasses		4	4		4	4		8	8		8	8	
Total Ammunition			976			1294			1354			1816	

TABLE III.

Equipment of Reserve *Field Batteries of Royal Foot Artillery, for either of the following pieces.*

Nature of Equipment.	Iron. 18-pr. Gun and 8-pr. Howitzer Battery.			Brass. 12-pr. Gun and 32-pr. Howitzer* Battery.			Brass. 9-pr. Gun and 24-pr. Howitzer Battery.			Remarks.
	Gun.	Howitzer.	Total.	Gun.	Howitzer.	Total.	Gun.	Howitzer.	Total.	
Ordnance.										See Artillery Plates I. & II., and Artillery Tables D. E. and F.
Guns	3		3	5		5	5		5	
Howitzers		1	1		1	1		1	1	
Total pieces of Ordnance			4			6			6	
Establishment.										
Captains			2			2			2	
Subalterns			3			3			3	
Serjeants			3			3			3	
Corporals			3			3			3	
Bombardiers			6			6			6	
Buglers			2			2			2	Three men are carried on the gun limber of the 12-pounder gun, two on the 9-pr., and with the 18-pr. iron 18 howitzer all are on foot.
Gunners			90			90			90	
Drivers, Lieutenant			1			1			1	
,, Staff Serjeant			1			1			1	
,, Serjeants			2			2			2	
,, Corporals			6			6			5	
,, Bugler			1			1			1	
,, Farrier			1			1			1	
,, Shoeing Smiths			4			4			4	
,, Carriage do.			1			1			1	
,, Collar-makers			2			2			2	
,, Wheelers			2			2			1	
,, Privates			102			99			84	
Medical Officer			1			1			1	
Total Establishment			233			230			213	
Carriages.										See Plates of the article 'Carriage.'
Gun and Howitzer carriages	3	1	4	5	1	6	5	1	6	
Gun and Howitzer spare do.	1		1	1		1	1		1	
Store waggons			2			2			1	
,, cart			1			1			1	
Forge waggon			1			1			1	
Platform do.			1							
Ammunition do.	9	4	13	10	2	12	7	2	9	
Total Carriages			23			23			19	
Horses.										This includes spare horses at $\frac{1}{10}$ per battery.
Riding			20			20			19	
Draught			170			164			137	
Baggage			8			8			8	
Total Horses			198			192			164	
Ammunition.										See Tables of article 'Ammunition' in respect to packing.
Round	132		396	120	*	600*	$121\frac{3}{5}$		608	
Case	12	12	48	14			$19\frac{1}{5}$	12	108	
Spherical do.	36	52	160	50			$25\frac{3}{5}$	72	200	
Shells		48	48					56	56	
Carcasses								4	4	
Total Ammunition			652						976	

* Arrangements not known.

TABLE IV.

Equipment of Light Field Batteries for Colonial *and* Mountain *Service.*

Nature of Equipment.	Colonial Service. 3-pr. Gun and Coehorn Howitzer on single draught. Gun.	Howitzer.	Total.	1-pr. Gun and Coehorn Howitzer on single draught. Gun.	Howitzer.	Total.	Remarks.	Mountain Service. 3-pr. Gun and Coehorn Howitzer or Pack Saddles. Gun.	Howitzer.	Total.	3-pr. Gun and Coehorn Howitzer on single draught. Gun.	Howitzer.	Total.	Remarks.
Ordnance.							See Table I. article 'Artillery.'							See Table I. article 'Artillery.'
Guns	3		3	3		3		3		3	3		3	
Howitzer		1	1		1	1			1	1		1	1	
Total pieces of Ordnance			4			4				4			4	
Establishment.							All dismounted except the Officer.							All dismounted except the Officer.
Lieutenant			1			1				1			1	
Non-com[d]. Officers			4			4				5			5	
Gunners			20			20				25			21	
Drivers, Corporal			1			1				2			2	
,, Shoeing Smith			1			1				1			1	
,, Privates			14			11				20			19	
Total Establishment			41			38				54			49	
Carriages.							See Table I. article 'Artillery,' and Plate in the article 'Carriage.'							The guns and howitzer only on draught.
Single draught											3		3	
Gun	3		3	3		3						1	1	
Howitzer		1	1		1	1								
Ammunition carts	6	2	8	3	2	5								
Total Carriages			12			9							4	
Horses or Mules.														The ammunition and stores carried on packs.
Riding			1			1				4			4	
Draught			26			20							4	
Pack										30			25	
Baggage										1			1	
Total Horses or Mules			27			21				35			34	
Ammunition.														
Round	125		375	150		450		72		216	96		288	
Case	29	12	99	15	12	57		12	12	48	20	16	76	
Shells		68	68		68	68			48	48		56	56	
Total Ammunition			542			575				312			420	

TABLE V.

Detail of Battering Train of 100 Pieces of Heavy Ordnance.

The 24-pounders at 1000 rounds per gun } exclusive of case and spherical.
The 12-pounders at 1200 rounds per gun }

The 10 and 8-inch shells at 600 per mortar and howitzer } exclusive of case and carcasses.
The $5\frac{1}{2}$ and $4\frac{2}{5}$-inch do. at 200 per do. do. }

Ordnance and Implements.	Guns. 24-pr.	Guns. 12-pr.	Howitzers. 10-in.	Howitzers. 8-in.	Mortars. 10-in.	Mortars. 8-in.	Mortars. $5\frac{1}{2}$-in.	Mortars. $4\frac{2}{5}$-in.	
Ordnance, brass	,,	,,	,,	,,	,,	,,	20	20	Equal number with the large mortars and howitzers. One-half of each nature of small mortars.
Ordnance, iron	40	20	5	10	10	15	,,	,,	In proportion of 6 guns and 4 mortars and howitzers.
Carriages, complete, travelling, with limbers	40	20	5	10	,,	,,	,,	,,	
Mortar beds and coins, wood	,,	,,	,,	,,	,,	,,	20	20	
Mortar beds and coins, iron	,,	,,	,,	,,	10	15	,,	,,	
Handspikes, traversing	,,	20	,,	10	,,	,,	,,	,,	
Handspikes, common	160	40	20	20	40	30	,,	,,	Heavy pieces at 4 each, light ditto at 2 each.
Hand crow-levers, 6 feet	40	20	5	,,	10	,,	,,	,,	
Iron crows, $5\frac{1}{2}$ feet	4	2	1	1	1	1	,,	,,	One for every 10 pieces of ordnance.
Sponges with staves, Rammers and bags	80	40	10	20	10	15	20	20	
Wadhooks with staves	10	5	,,	,,	,,	,,	,,	,,	One for every 4 guns.
Ladles with ditto	10	5	,,	,,	,,	,,	,,	,,	One for every 4 guns.
Jacks, hand-screw, large	10	5	2	3	,,	,,	,,	,,	One for every 4 guns and howitzers.
Grease boxes	40	20	5	10	,,	,,	,,	,,	
Lintstocks with cocks	40	20	5	10	10	15	20	20	
Claw hammers	40	20	5	10	10	15	,,	,,	
Punches for vents	80	40	10	20	20	30	40	40	
Priming irons, long, sets	40	20	5	10	10	15	20	20	
Portfire clippers, pairs	20	10	3	5	5	8	10	10	One to 2 pieces.
Powder horns, new pattern	40	20	5	10	10	15	20	20	
Gun locks*	44	22	6	11	,,	,,	,,	,,	One for every gun and howitzer, and $\frac{1}{10}$ spare.
Musket flints*	Two thousand,								or about 25 flints per lock.

* In these and other instances, throughout, the detonating principle would now be followed to a great extent; but this Table is given exactly as in the original.

TABLE V.—*Continued.*

Ordnance and Implements.	Guns.		Howitzers.		Mortars.				
	24-pr.	12-pr.	10-in.	8-in.	10-in.	8-in.	$5\frac{1}{2}$-in.	$4\frac{2}{5}$-in.	
Cylinders of wood for cartridges	80	40	,,	,,	,,	,,	,,	,,	
Junk wads	4000	2000	,,	,,	,,	,,	,,	,,	One in 10 rounds.
Straps for side-arms	40	20	5	10	,,	,,	,,	,,	Sets complete.
Men's harness, heavy, sets	80	20	10	10	20	15	,,	,,	Having an additional pair of loops to increase them to 16 a set. Two sets for every 24-pounder and 10-inch mortar and howitzer, and one set for the others.
Leather buckets	80	40	10	20	20	30	4	4	
Marline, skeins	40	20	5	10	10	15	,,	,,	
Hambro' line	40	20	5	10	10	15	,,	,,	
Common spikes	200	100	25	50	50	75	,,	,,	5 for every piece of ordnance.
Spring spikes	,,	,,	,,	,,	,,	,,	,,	,,	
Spare sponge staves	80	40	10	20	10	15	20	20	
Spare heads, sponge	80	40	10	20	20	30	20	20	
Spare heads, rammer	80	40	10	20	,,	,,	,,	,,	
Spare forelock keys	80	40	10	20	,,	,,	,,	,,	
Spare forelock rings	80	40	10	20	,,	,,	,,	,,	
Spare linchpins, fore	80	40	10	20	,,	,,	,,	,,	
Spare linchpins, hind	80	40	10	20	,,	,,	,,	,,	
Spare washers, fore	80	40	10	20	,,	,,	,,	,,	
Spare washers, hind	80	40	10	20	,,	,,	,,	,,	
Ammunition and Laboratory Stores.									
Shot, round	40,000	24,000	,,	,,	,,	,,	,,	,,	1000 rounds each 24-pounder; 1200 each 12-pounder.
Shot, case, common tier shot	2000	1000	,,	,,	,,	,,	,,	,,	50 rounds a gun.
Shot, case, spherical	4000	2000	,,	3000	,,	,,	,,	,,	100 rounds a gun, and 300 for 8-inch howitzer.
Shot, pound, rounds 100 each	,,	,,	,,	,,	500	,,	,,	,,	50 for each 10-inch mortar.
Shells, common, empty	,,	,,	3000	3000	6000	9000	4000	4000	
Carcasses, round, fixed	,,	,,	50	100	100	150	,,	,,	10 rounds for each 10 and 8-inch mortar and howitzer.

[illegible]	„	„	„	—	500	„	„	„	100 proportions each 10-inch mortar and howitzer.
Valenciennes composition	„	„	500	„	1000	„	„	„	
Gunpowder: large grain, whole barrels of 90 lbs. each	3455	1066	194	333	466	400	66	44	This is calculated for the number of rounds at the Service charge, and is required exclusive of powder in cartridges. The fine powder forms part of the 24-pounder calculation, and is placed in that column, but it is intended for the general service of the equipment, and is calculated at 2 whole barrels per piece.
Gunpowder: fine grain, half barrels of 45 lbs. each, or 18,000 lbs.	400	„	„	„	„	„	„	„	
Gunpowder: mealed, lbs.	40	20	5	10	10	15	„	„	1 lb. for each piece.
Flannel Cartridges: filled, Service charge	6000	3000	500	1000	„	„	„	„	One cartridge for each round, including those filled, and with $\frac{1}{10}$ spare.
Flannel Cartridges: empty, for Service charge	44,600	26,700	2850	5700	„	„	„	„	
Flannel Cartridges: empty, 8-ounce	„	„	„	„	„	„	2000	2000	Cartridges equal to $\frac{1}{2}$ the number of rounds.
Paper caps for cartridges	20,000	12,000	„	„	„	„	„	„	As a substitute for wads, if wanted, 1 for 2 rounds.
Twine for choking ditto	One hundred pounds.								1 lb. for every 1000 cartridges.
Packthread for cartridges	One hundred pounds.								1 lb. for every 1000 cartridges.
Fuzes, Graduated: spherical	8000	4000	„	6000	„	„	„	„	2 for each spherical shell.
Fuzes, Graduated: common	„	„	4500	4500	9000	13,500	6000	6000	$1\frac{1}{2}$ for each common shell.
Fuze augers	20	10	„	10	„	„	„	„	1 for every 2 guns. 1 for each 8-inch howitzer.
Tubes, brass	One hundred and twenty-seven thousand, being 1 for each round, and $\frac{1}{5}$ spare.								
Tube pockets with straps	80	40	10	20	20	30	20	20	
Match: slow, cwts.	10	5	$1\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{3}{4}$	5	5	$\frac{1}{4}$ cwt. for each heavy piece, and the same quantity for the small mortars.
Match: quick, lengths	„	„	„	„	6000	9000	„	„	
Match: quick, in bales, yards	Four hundred.								
Portfires: long small	Three thousand.								One for every 12 rounds, $\frac{1}{3}$ of which common portfires, $\frac{2}{3}$ blue paper ditto.
Portfires: blue paper	Six thousand.								
Portfire sticks	80	40	10	20	20	30	20	20	
Cutting knives	40	20	5	10	10	15	20	20	
Scissars, pairs	40	20	5	10	10	15	20	20	
Worsted, lbs.	10	5	1	3	„	„	„	„	$\frac{1}{4}$ lb. each gun and howitzer.
Needles	120	60	15	30	„	„	„	„	3 needles each gun and howitzer.
Thumbstalls	80	40	10	20	20	30	20	20	

TABLE V.—*continued.*

Ordnance and Implements.	Guns.		Howitzers.		Mortars.				
	24-pr.	12-pr.	10-in.	8-in.	10-in.	8-in.	$5\frac{1}{2}$-in.	$4\frac{2}{3}$-in.	
Copper powder measures { 4 lb. to 1 oz. sets }	8	4	1	2	2	3	"	"	A set for 5 pieces.
Copper scales with beams	"	"	"	"	2	3	2	2	1 in 5 for large mortars; 1 in 10 for small ditto.
Brass weights, 4-lb. piles	"	"	"	"	2	3	2	2	Ditto, ditto.
Mallets	"	"	5	10	10	15	20	20	1 mallet and 2 setters for each mortar and howitzer.
Setters	"	"	10	20	20	30	40	40	
Tenon saws	20	10	3	5	5	8	10	10	1 for every 2 pieces.
Setters for saws	20	10	3	5	5	8	10	10	
Files, 3-square	20	10	3	5	5	8	10	10	
Quadrants, brass	"	"	1	2	2	3	"	"	1 for every five 10-inch and 8-inch mortars and howitzers.
Perpendiculars	"	"	1	2	2	3	"	"	
Box rules	8	4	1	2	2	3	"	"	A rule for 5 pieces.
Compasses	"	"	1	2	2	3	"	"	1 for 5 mortars and howitzers.
Funnels { tin for filling	10	5	3	5	5	8	10	10	1 in 4 for guns; 1 in 2 for mortars and howitzers.
Funnels { ditto for loading	"	"	"	"	5	8	"	"	1 in 2 for large mortars.
Corkscrews	10	5	3	5	5	8	10	10	1 in 4 for guns; 1 in 2 for mortars and howitzers.
Engines for drawing fuzes	"	"	1	2	2	3	"	"	1 in 5.
Pincers, pairs, iron	8	4	"	"	"	"	4	4	1 in 5.
Scrapers for shells	"	"	3	5	5	8	10	10	
Lead plummets	"	"	"	"	10	15	20	20	
Shell-hooks, pairs, hand	"	"	10	"	20	"	"	"	
Cartouches of leather, large	40	20	5	10	10	15	20	20	
Budge barrels	"	"	5	10	10	15	5	5	1 for each large mortar and howitzer, and 1 for 4 small mortars.
Blue lights	One hundred.								For signals.
Hazel hoops for powder barrels	"	"	"	"	"	"	"	"	A hoop for 10 barrels, if used.
Copper { adzes	"	"	"	"	"	"	"	"	A set for every 500 barrels of powder, if barrels are used.
Copper { drivers	"	"	"	"	"	"	"		
Copper { vices	"	"	"	"	"	"	"	"	
Copper { can-hooks, pairs, with slings	"	"	"	"	"	"	"	"	

TABLE V.—*continued.*

Spare Transporting and other Carriages, &c., for Battering Train.

	Spare Carriages for Ordnance.				Waggons.			Carts.			Carriages.					
	24-pounders.	12-pounders.	10-in. howitz.	8-in. howitz.	Flanders pattern.	Store.	Forge.	Hand, with Shafts.	Sling.	Trench.	Devil. Large.	Devil. Small.	Platform.	Drag. Large	Drag. Small.	
No. of carriages	4	2	1	1	100	10	10	50	10	50	,,	2	25	5	5	1 spare carriage for 10 pieces of ordnance.
Covers, waggon, painted	,,	,,	,,	,,	100	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	
Covers, cart, do.	,,	,,	,,	,,	,,	,,	,,	50	,,	,,	,,	,,	,,	,,	,,	
Grease boxes	4	2	1	1	100	10	10	,,	,,	,,	,,	,,	25	,,	,,	
Jacks, hand-screw, large	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	6	,,	,,	1 for 4 platform waggons.
Jacks, lifting	,,	,,	,,	,,	20	2	2	,,	,,	,,	,,	,,	,,	,,	,,	1 in 5 for waggons.
Linchpins, spare	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	1 per carriage.
Chests of tools, with anvils, blocks, and beak irons	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	Forges to be completed with these articles.

Horse Harness for Carriages.

Horse harness complete, with whips, leggins, head-stall halters, &c.	24-pounders.	12-pounders.	10-in. howitz.	8-in. howitz.	Flanders pattern.	Store.	Forge.	Hand, with Shafts.	Sling.	Trench.	Devil. Large.	Devil. Small.	Platform.	Drag. Large	Drag. Small.	Single Wheel.	Single Draft.	General Total.	
wheel	8	4	2	2	200	20	20	,,	,,	,,	,,	,,	50	,,	,,	306	,,	306	18 platform waggons at 8 horses each for the mortars, and the remaining 7 at 4 horses each.
leader	16	4	4	2	200	20	20	,,	,,	,,	,,	,,	122	,,	,,	,,	388	388	
off-wheel	,,	,,	,,	,,	,,	,,	,,	50	,,	50	,,	,,	,,	,,	,,	100	,,	100	

Horse Harness for Ordnance.

Horse harness complete, with whips, leggins, head-stall halters, with chain reins, &c.

	Forty 24-prs. at 10 Horses.	Twenty 12-prs. at 6 Horses.	Five 10-inch Howitzers at 10 Horses.	Ten 8-inch Howitzers at 6 Horses.	Single Wheel.	Single Draft.	General Total.	
Wheel	80	40	10	20	150	,,	150	No spare harness necessary with battering equipments, as the whole of the allotted proportions can hardly, under any circumstances, be expected to be in use at once.
Leader	320	80	40	40	,,	480	480	
General Total Harness					556	868	1424	

TABLE V.—*continued.*

GENERAL STORES.			No.	
Triangle gyns	Common		8	About 1 for every 12 pieces.
Iron blocks with brass sheaves	Treble		„	Complete for 8 gyns.
	Double		„	
White rope, fathoms	6-inch for slings		„	
	4-inch for falls		„	
Crab capstan	complete		2	1 for 50 pieces.
Purchase-block with brass sheaves	Treble		5	1 for 20 pieces.
	Double		5	
	Single		5	
Tarred rope	Coils	4½-inch	4	1 for 25 pieces.
Blocks	Double	10 „	8	Equal to number of gyns.
		8 „	8	
	Single	10 „	8	
		8 „	8	
		5½ „	8	
Rope, coils	Tarred	4 „	4	1 for 25 pieces.
		3 „	5	1 for 20 pieces.
		2 „	5	1 for 20 pieces.
		1 „	10	1 for 10 pieces.
	White	6 „	1	
		4 „	1	
		3 „	1	
		2 „	1	
Spun yarn	Coils		5	1 for 20 pieces.
Ratline	Do.		5	1 for 20 pieces.
Iron and Steel	Iron, of sorts	Tons	2	1 ton for 50 pieces.
	Steel, cwt.	Sheer	1	½ of each for 50 pieces.
		Blister	1	
Coals	Chaldrons		5	A chaldron for 20 pieces.
Candles	Cwt.		1	
Grease	Kegs		200	2 per piece.
Lanthorns	Muscovy		10	1 for 10 pieces.
	Tin		20	1 for 5 pieces.
	Dark		20	
For securing of powder	Tanned hides		50	1 for 5 pieces.
	Wadmilltilts		50	
	Hair cloths		100	1 per piece.
	Tarpaulins	30 ft. by 15	25	1 for 4 pieces.
		20 „ 16	25	
		14 „ 10	100	1 per piece.
Horse-shoes with 3 sets of nails each				3 sets of shoes for every single horse harness.
Shoeing tools				1 set for every 50 ditto.
Park pickets				1 for 5 single horse harness.
Wood mauls				1 for 10 pickets.
Nose-bags, new pattern				3 for every 2 horses' harness.
Corn sacks				1 for 4 ditto.
Forage cords, sets				1 for 2 ditto.
Additional head collars				1 in 5 of No. of single sets of harness.
Tools.				
Chests of Tools.	Collar-makers'		4	1 for 25 pieces.
	Wheelers'		8	1 for 12 pieces.
	Smiths'		4	1 for 25 pieces.
	Coopers'		2	1 for 50 pieces, if barrels are used.
Heavy sledge hammers			4	For knocking off trunnions.
Wrench hammers, of sizes			10	1 for 10 pieces.

TABLE V.—*continued.*

GENERAL STORES.			No.	
Intrenching Tools.	Axes	Felling	50	1 for 2 pieces.
		Pick	100	1 for each piece.
	Spades		100	1 for each piece.
	Shovels		100	
	Hand	Bills	100	
		Hatchets	100	
	Barrows	Hand	50	1 for 2 pieces.
		Wheel	50	
	Grind-stones with trough		2	1 for 50 pieces.
	Helves for	Spades	50	Half in spare.
		Shovels	50	
		Felling-axes	25	
		Pick-axes	50	
	Pit saws		2	
	Cross-cut saws		2	
	Hand saws		10	1 for 10 pieces.
	Setters for saws	Pit	2	
		Cross-cut	2	
		Hand	2	
	Files for saws, dozens	Pit	2	
		Cross-cut	2	
		Hand	3	
Nails	Clasp	40-penny	3000	30 of sorts, per piece.
		30 ,,	2000	20
		20 ,,	4000	40
		10 ,,	4000	40
		6 ,,	2000	20
	Streak, of sorts		3000	30
Marline spikes			4	
Screws, of sorts, gross			10	1 gross for 10 pieces.
Glue, lbs.			10	1 lb. for 10 pieces.
Oaken skidding, 6 × 8 *running*			80	feet.
Oak plank, 3-inch ends			,,	
Plank, superficial feet	Elm	1-inch	50	
		¾ ,,	50	
	Ash	1½ ,,	,,	
		1 ,,	,,	
Deals	Sawed		25	1 in 4 pieces.
	Whole		25	
Iron shot-gauges, sets			4	
Brass callipers, large, pairs			2	
Grates for heating shot			3	1 for 20 guns.
Fire irons for ditto, sets			,,	In proportion to the grates.
Shot bearers				
Spare.				
Wheels	24-pounder	gun	8	One spare wheel in 10 for gun and howitzer wheels, 1 spare wheel in 20 for gun and howitzer limbers and the wheels of all other carriages.
		limber	4	
	12-pounder	gun	4	
		limber	2	
	10-inch	howitzer	1	
		limber	,,	
	8-inch	howitzer	2	
		limber	1	
	Waggons, Flanders pattern	fore	10	
		hind	10	
	Waggons, Forge		2	
	Platform carriage	fore	3	
		hind	3	
	Sling cart		2	
	Hand cart		5	
	Trench cart		5	

TABLE V.—*continued.*

GENERAL STORES.		No.		
Axletrees.—Iron, whole	24-pounder	5	1 in 10 of ordnance	With beds of wood in proportion.
	10-inch howitzer	5		
	12-pounder	3		
	8-inch howitzer	3		
Axletree arms.—Iron, of sorts		35	1 in 10 of carriages	
Common handspikes		300	3 spare per piece.	
Traversing ditto		15	1 for two 12-pounders and 8-inch howitzers.	
Bail hoops		200	2 for each Flanders pattern waggon.	
In the rough.				
Spokes, of sorts		”	In quantity equal to spare wheels.	
Felloes				
Shafts, of sorts		70	1 in 5 of the number of carriages.	
Splinter-bars, of sorts		25	1 in 10 of all 4-wheel carriages.	
Guides	Fore	12	1 in 20 of all 4-wheel carriages.	
	Hind	12		
Under-poles		10	1 in 10 for Flanders pattern waggon.	
Naves		10		
Tail-pieces		10		
Sweep-bars		10		
Shaft-bars, of sorts		25	1 in 10 of 4-wheel carriages.	
Iron tire		”	Equal $\frac{1}{4}$th the material for repairing wheels.	
Camp equipage*		”	In the proportion as heretofore, according to the numbers requiring it.	
Laboratory tents* complete, with poles, pins, and mallets		5	1 for 20 pieces.	
Collar-makers' Materials for Three Months.				
Harness leather	Stout hides	14	1 hide	to 100 sets of single harness.
	Light do.	7	$\frac{1}{2}$ ditto	
Basils—Dozens, of sorts		28	2 dozen	
Webb	Gunners' girth, yards	112	8 yards	
	Surcingle do.	42	3 yards	
Pannel serge, yards		70	5 yards	
Does' or curled hair, lbs.		210	15 lbs.	
Thread	Hemp, lbs.	42	3 lbs.	
	Collar ”	28	2 lbs. each	
	Dutch ”	28		
Harness and bridle buckles, of sorts, dozens		42	3 dozen	
Nails, of sorts		7000	500 nails	
Tacks, of sorts		7000	500 tacks	
Bristles, lbs.		7	$\frac{1}{2}$ lb.	
Needles, of sorts		1400	100 needles	
Whip-cord, lbs.		21	$1\frac{1}{2}$ lb.	
Tin pans for oil		42	3 pans	
Wax	Black, lbs.	14	1 lb.	
	Bees', ”	7	$\frac{1}{2}$ lb.	
Neats'-foot oil, gallons		21	$1\frac{1}{2}$ gallon	
Tallow		14	1 lb.	
Punches, of sorts		140	10 punches	
Awls		140	10 awls	

* See 'Castrametation,' p. 222.

TABLE VI.*

General Return of Ordnance, Carriages, Ammunition, and Stores, which composed the Battering Train employed on the North Coast of Spain, with the Expenditure at the Siege of St. Sebastian.

Passages, 31st December, 1813.

ARTILLERY STORES.

		Total sent from England.	Left at † St. Sebastian.	Expended at the Siege.
Ordnance	24-pounders	75	23	1
	18 „	8	8	„
	8-inch howitzers	24	„	„
	68-pounder carronades	16	„	„
	13-inch mortars	4	„	„
	10 „ „	20	„	1
Travelling carriages, with limbers complete	24-pounders	73	„	1
	18 „	„	„	„
	8-inch howitzers	32	„	„
Block trail carriages	68-pounder carronades	16	„	„
Iron beds for mortars	13-inch	4	„	„
	10 „	20	„	1
Platform carriages for guns and mortars		90	„	„
Traversing platforms, complete	24-pounders	15	4	„
	18 „	8	2	„
Flanders pattern waggons		106	„	„
Store limber carriages		32	„	„
Sling carts		3	1	„
Hand carts		16	6	„
Standing carriages	24-pounders	17	13	„
	18 „	9	9	„
Trench carts		16	6	„
Devil carriages		1	„	„
Forge waggons, complete, with bellows, &c.		25	„	„
Handspikes	common	1275	116	102
	traversing 8-inch howitzers	56	„	20
Sponges, with staves, rammers, and bags	24-pounders	150	10	50
	18 „	16	16	„
	8-inch howitzers	48	„	13
	68-pounder carronades	32	„	„
	13-inch mortars	8	„	„
	10 „ „	40	„	„
Spare sponge staves	24-pounders	73	9	28
	18 „	8	8	„
	8-inch howitzers	24	„	10
	13-inch mortars	4	„	„
	10 „ „	20	„	8
Wadhooks	24-pounders	75	3	15
	18 „	8	8	„
	68-pounder carronades	16	„	4
Ladles, with staves	24-pounders	48	3	9
	18 „	8	8	„
Lintstocks		88	9	15

* From Mr. Butcher, Ordnance Storekeeper, Dublin; and at St. Sebastian, 1813.

The whole of these stores, with perhaps 1-10th of their bulk of Engineer stores, were shipped in 24 transports; of which 22 averaged 313 tons each,—the other two were 588 and 625;—in all, about 8100 tons. These vessels, in the Ordnance invoices, were registered in groups of 1500 tons each, and the above items were divided among them in about equal proportions of that amount.

† The purport of this column was misapprehended, or it would not have been inserted, being irrelevant. It merely gives the quantity of stores ordered by the Duke of Wellington to be left behind on the advance of the army after the capture of St. Sebastian.

TABLE VI.—*continued.*

		Total sent from England.	Left at St. Sebastian.	Expended at the Siege.
Field tampeons, with collars	24-pounders	76	5	31
	18 "	8	6	2
	8-inch howitzers	28	"	6
	68-pounder carronades	16	"	4
	13-inch mortars	2	"	"
	10 " "	24	"	20
Muzzle caps	13-inch	2	"	"
Hand-screws, large		58	"	6
Slow-match, cwts.		75½	4½	28
Spare sponge heads	24-pounders	77	9	19
	18 "	8	6	2
	8-inch howitzers	24	"	8
	68-pounder carronades	16	"	2
	13-inch mortars	4	"	"
	10 " "	20	"	12
Spare rammer heads	24-pounders	77	9	29
	18 "	8	6	2
	8-inch howitzers	24	"	5
	68-pounder carronades	16	"	1
	13-inch mortars	4	"	"
	10 " "	20	"	11
Painted covers for	24-pounders	58	"	30
	8-inch howitzers	24	"	8
	Flanders pattern waggons	104	"	6
	Forge waggons	25	"	5
	Ammunition	78	"	5
	Harness	25	"	"
Drag ropes, heavy, pairs		175	"	47
Men's harness, heavy, sets		106	24	31
Aprons of lead,	large	89	11	28
	middling	58	"	15
Claw hammers		230	11	60
Punches for vents		258	26	53
Priming irons, long, sets		147	11	3
Spikes,	spring	28	"	5
	common	760	72	142
Portfire clippers, pairs		160	15	23
Powder horns		147	11	48
Marline, skeins		255	12	36
Hambro' line, skeins		123	"	69
Budge barrels, H. H.		85	14	23
Straps for side-arms		440	"	180
Tallow, lbs.		104	"	32
Grease,	firkins of	37	"	3
	boxes for	248	2	91
French water-buckets		84	"	36
Linchpins		394	13	119
Washers		217	"	74
Clouts,	body	500	"	166
	linch	500	"	166
Clout nails		6,720	"	2,200
Forelocks,	keys	44	"	16
	rings	44	"	16

TABLE VI.—*continued.*

	Total sent from England.	Left at St. Sebastian.	Expended at the Siege.
Packthread, lbs.	195	13	98
Cases of wood	100	9	45
Junk wads, 24-pounders	121,650	3,300	16,991
Junk wads, 18 „	34,000	1,791	9,209
Junk wads, 68-pounder carronades	700	„	„
Ammunition.			
Number of rounds for 24-pounders, round	101,997	„	43,367
Number of rounds for 24-pounders, case and grape	5,212	„	1,774
Number of rounds for 24-pounders, spherical	17,860	„	1,930
Number of rounds for 18-pounders, round	32,716	„	9,303
Number of rounds for 18-pounders, case and grape	1,400	„	18
Number of rounds for 18-pounders, spherical	4,500	„	150
Number of rounds for 68-pounder carronades and howitzers, round	700	„	„
Number of rounds for 68-pounder carronades and howitzers, case and grape	1,500	„	„
Number of rounds for 68-pounder carronades and howitzers, spherical	11,700	„	2,198
Number of rounds for 68-pounder carronades and howitzers, common shells	15,000	„	7,672
Number of rounds for 68-pounder carronades and howitzers, carcasses	200	„	„
Number of rounds for 13-inch mortars, common shells	1,694	„	„
Number of rounds for 13-inch mortars, carcasses	103	„	„
Number of rounds for 10-inch, common shells	9,380	„	3,675
Number of rounds for 10-inch, carcasses	220	„	„
Iron, round, 1-lb. shot	114,200	„	7,700
Bottoms of wood for ditto	1,092	„	56
Valenciennes composition, lbs.	1,582	„	380
Powder, L. G., barrels, 90 lbs. each	15,674	638	5,579 barrels, and 5 lbs.
Powder, L. G., barrels, 45 lbs. each	„	„	„
Powder, F. G., lbs.	168	17	22½
Powder, Mealed, lbs.	53	„	11
Cartridges, Filled, 24-pounders, 8 lbs.	40*	3,408*	„
Cartridges, Filled, 24-pounders, 3 lbs.	320	„	„
Cartridges, Filled, 24-pounders, 6 oz.	320	„	„
Cartridges, Filled, 18 „ 6 lbs.	„	755	„
Cartridges, Filled, 68-pounder carronades and 8-inch howitzers, 4 lbs.	„	86	„
Cartridges, Filled, 68-pounder carronades and 8-inch howitzers, 3 lbs.	200	47	„
Cartridges, Empty, 24-pounders, 8 lbs.	100,850	18	53,882
Cartridges, Empty, 24-pounders, 3 lbs.	17,498	„	2,500
Cartridges, Empty, 24-pounders, 2 lbs.	35,000	„	4,400
Cartridges, Empty, 24-pounders, 6 oz.	17,498	„	5,250
Cartridges, Empty, 18-pounders, 6 lbs.	24,500	3,216	6,284
Cartridges, Empty, 18-pounders, 2 lbs.	4,500	„	1,500
Cartridges, Empty, 18-pounders, 1½ lb.	9,000	„	
Cartridges, Empty, 18-pounders, 5 oz.	4,000	„	1,000
Cartridges, Empty, 68-pounder carronades and 8-inch howitzers, 4 lbs.	8,222	„	3,750
Cartridges, Empty, 68-pounder carronades and 8-inch howitzers, 3½ lbs.	30,000	„	15,000
Cartridges, Empty, 68-pounder carronades and 8-inch howitzers, 2 lbs.	6,000	„	„
Cartridges, Empty, 68-pounder carronades and 8-inch howitzers, 1 lb. 14 oz.	15,000	„	4,000
Cartridges, Empty, 68-pounder carronades and 8-inch howitzers, 15 oz.	11,700	„	2,700
Tubes, brass	330,000	6,000	84,232
Tubes, tin	16,980	5,280	2,420
Portfires	21,709	352	9,114

* Filled on the spot,—cartridges sent out empty.

TABLE VI.—*continued.*

	Total sent from England.	Left at St. Sebastian.	Expended at the Siege.
Portfires, blue paper	256	176	67
Portfire sticks	294	"	82
Tube boxes	292	13	38
Cutting knives	156	17	51
Scissars	156	17	49
Worsted	lbs. oz. 21 3½	"	"
Needles	398	"	118
Thumbstalls	276	"	73
Flax, lbs.	67	"	7
Tow	lbs. oz. 19 2	"	lbs. oz. 4 2
Mallets and setters	60 : 132	"	8 : 37
Files	248	"	23
Rasps	62	"	18
Tenon saws	56	"	"
Diagonal scales	130	"	46
Coarse twine, lbs.	144	"	69
Perpendiculars	58	"	18
Quadrants, brass	58	"	2
Compasses, brass	61	"	7
Pincers, pairs, copper	98	"	29
Pincers, pairs, iron	29	"	4
Copper salting boxes	28	"	3
Corkscrews	130	"	24
Spoke-shaves	58	"	5
Wood vices	98	"	8
Fuze augers	92	"	17
Funnels, copper	48	"	"
Funnels, tin	80	"	7
Funnels, tin, for loading mortars	24	"	"
Copper powder measures, 4 lbs.	45	8	"
Copper powder measures, 2 lbs.	65	8	"
Copper powder measures, 1 lb.	56	8	1
Copper powder measures, 8 oz.	44	"	4
Copper powder measures, 4 oz.	42	"	1
Copper powder measures, 2 oz.	40	"	"
Copper powder measures, 1 oz.	40	"	1
Dutch thread, lbs.	168	"	60
Scrapers for shells	37	"	"
Cartouches of leather, large	330	30	108
Sheepskins	110	"	47
For spherical fuzes. Tin boxes, white	96	"	5
For spherical fuzes. Tin boxes, blue	96	"	5
For spherical fuzes. Tin boxes, black	96	"	5
For spherical fuzes. Canvas bags, yellow	96	"	4
For spherical fuzes. Canvas bags, red	96	"	4
For spherical fuzes. Canvas bags, green	96	"	4
Leather straps for boxes	118	"	46
Leather straps for bags	118	"	46

TABLE VI.—*continued.*

	Total sent from England.	Left at St. Sebastian.	Expended at the Siege.
Fuzes, common, 13-inch	1,900	„	„
Fuzes, common, 10 „	18,450	„	5,495
Fuzes, common, 8 „	30,000	„	10,440
Fuzes, spherical, 8-inch, uncut	9,000	„	3,000
Fuzes, spherical, 8-inch, cut	54,000	„	4,120
Fuzes, spherical, 5½ „ uncut	24,700	„	3,948
Fuzes, spherical, 5½ „ cut	107,598		
Quick-match, lengths	180,201	„	„
Engines for drawing fuzes	28	„	„
Shell-hooks, pairs	72	„	15
Tangent scales, brass	„	„	„
Lead plummets	27	„	„
Copper scales, with beams	28	„	„
Brass weights, sets, 4 lbs. to ¼ oz.	30	„	„
„ „ „ 2 lbs. to ¼ oz.	4	„	2

General Stores.

	Total sent from England.	Left at St. Sebastian.	Expended at the Siege.
Triangle gyns, complete, with blocks, &c.	16	1	3
Triangle gyns, incomplete	„	„	„
Cambeons*	„	„	„
White rope, Fathoms, 6-inch	38	„	„
White rope, Fathoms, 4 „	98	„	„
White rope, Fathoms, 2½ „	1,130	„	„
White rope, Fathoms, 1 „	130	„	„
White rope, Coils, 6½ „	2	„	1
White rope, Coils, 6 „	1	„	„
White rope, Coils, 5 „	„	„	„
White rope, Coils, 4½ „	5	„	„
White rope, Coils, 4 „	4	„	2
White rope, Coils, 3½ „	4	„	„
White rope, Coils, 2½ „	65	„	20
White rope, Coils, 1 „	16	„	5
White rope, Coils, ½ „	15	„	5
Tarred rope, ends, old	„	„	„
Tarred rope, coils, 4½-inch	7	„	2½
Tarred rope, coils, 3 „	5	„	1
Tarred rope, coils, 2 „	5	„	1
Tarred rope, coils, 1 „	9	„	2
Purchase-blocks, with brass sheaves, treble	5	„	„
Purchase-blocks, with brass sheaves, double	5	„	„
Purchase-blocks, with brass sheaves, single	4	„	„
Spun-yarn, coils	16	„	3
Ratline, ditto	8	„	2
Grates for heating shot, complete, with tongs, &c.	13	„	„
Junk, cwts.	98	„	„
Coals, chaldrons	13	„	4
Candles, lbs.	896	„	280
Crab capstan, complete	1	„	„

* The long wooden joints of the centre chain of bullock harness.

TABLE VI.—*continued.*

	Total sent from England.	Left at St. Sebastian.	Expended at the Siege.
Spare wheels for 24-pounders, gun	57	,,	17
Spare wheels for 24-pounders, limber	41	,,	11
Spare wheels for 8-inch howitzers, gun	24	,,	8
Spare wheels for 8-inch howitzers, limber	16	,,	6
Spare wheels for Devil carriages, fore	,,	,,	,,
Spare wheels for Devil carriages, hind	1	,,	,,
Spare wheels for Platform carriages, fore	85	,,	,,
Spare wheels for Platform carriages, hind	85	,,	10
Spare wheels for Ammunition waggons, fore	12	,,	4
Spare wheels for Ammunition waggons, hind	12	,,	4
Spare wheels for Forge waggons	25	,,	6
Spare wheels for Store limber carriages	40	,,	3
Iron, Assorted, tons	4	,,	,,
	cwt. qrs. lbs.		
Iron, Flat, $6 \times \frac{3}{8}$, $5 \times \frac{5}{8}$, $2 \times \frac{1}{2}$	17 1 17	,,	,,
Iron, Flat, $1\frac{1}{2} \times \frac{1}{2}$	6 0 24	,,	,,
Iron, Round, $1\frac{1}{2}$	1 1 24	,,	,,
Iron, Round, $1\frac{1}{4}$	1 2 4	,,	,,
Iron, Rod, $\frac{1}{2}$ square, $\frac{1}{2}$ round	8 1 14	,,	,,
Iron, Bolstaff	5 2 0	,,	,,
Iron, Sheet	0 0 14	,,	,,
Iron, Rolled plate, $6 \times \frac{1}{8}$	4 0 16	,,	,,
Iron, Square, 1 inch, $\frac{7}{8}$,, $\frac{3}{4}$,,	26 2 13	,,	,,
Iron, Casement	11 0 14	,,	,,
			cwt. qrs. lbs.
Steel, Sheer	6 2 14	,,	5 0 0
Steel, Blister	2 0 14	,,	0 2 0
Horse harness, sets, Rope trace, wheel	356	,,	,,
Horse harness, sets, Rope trace, leader	418	,,	,,
Horse harness, sets, Chain, trace, thill	37	6	,,
Whips, long	9	,,	,,
Whips, short	405	,,	,,
Leggins for drivers	387	,,	,,
Head-stall halters, with chain reins	774	,,	,,
Couples for traces	87	12	,,
Stoppers and laniards	54 & 88	,,	,,
Bit halters	37	6	,,
Wanties	24	2	,,
Park pickets	20	,,	,,
Grease, kegs	362	,,	90
Tallow, firkins	9	,,	3
Hand-crow levers, 6 feet	172	24	44
Hand-crow levers, 5 feet	84	,,	24
Iron crows, $5\frac{1}{2}$ feet	62	,,	13
Iron crows, $4\frac{1}{2}$ feet	40	,,	14
Tanned hides	115	7	2
Wadmilltilts	77	,,	10

TABLE VI.—*continued.*

		Total sent from England.	Left at St. Sebastian.	Expended at the Siege.
Hair cloths		48	6	4
Tarpaulins,	large	90	„	10
	small	800	„	200
Corn sacks		410	100	„
Chests of tools for	Wheelers	25	1	„
	Carpenters	9	„	„
	Smiths	22	1	„
	Farriers	2	1	„
	Collar-makers	9	2	„
	Coopers	8	„	„
	Tinmen	6	„	„
	Forge carts	25	„	„
Coopers' jointer-planes		4	„	1
Coopers' tools, sets		„	„	„
Shoes with nails, sets,	Horse	5,500	„	„
	Mule	5,000	„	„
Bellows, pairs,	Smiths'	4	„	„
	Forge cart	6	„	„
Lanthorn,	Muscovy	80	„	10
	Tin	132	„	„
	Dark	84	„	„
Oil, gallons,	Linseed	40	„	„
	Train	40	„	„
	Sweet	41	„	„
	Neats'-foot	55	„	„
Spirits of turpentine, gallons		12	„	„
Paint, lead colour, cwts.		12	„	3
Paint brushes,	large	24	„	„
	small	24	„	„
Brushes, Pound,	0 0 0	4	„	„
	0 0	4	„	„
	0	4	„	„
Brushes, Sash tools,	No. 8	4	„	„
	„ 6	16	„	„
	„ 3	16	„	„
Copper	Adzes	31	2	2
	Drivers	46	2	5
	Vices	31	2	3
	Can-hooks, pairs	27	„	„
Hammers,	Wrench	48	„	12
	Claw	„	„	„
Iron shot-gauges, sets		7	1	„
Spikes, marline		80	„	17
Twine, lbs.		19	„	„
Hambro' line, skeins		175	„	25
Borax, lbs.		8	„	2
Spelter, lbs.		8	„	2
Resin, lbs.		8	„	2
Tin, sheets		400	„	„
Charcoal, bushels		40	„	„
Searchers, with reliefs		4	„	1

TABLE VI.—*continued.*

	Total sent from England.	Left at St. Sebastian.	Expended at the Siege.
Union flags, large	8	,,	1
Union flags, small jacks	8	,,	2
Ordnance jacks	8	,,	1
Flag staves	8	,,	1
Brass callipers, large, pairs	7	,,	,,
Screws, of sorts, grosses	46	,,	10
Tacks, of sorts, in No.	65,000	,,	,,
	lbs. oz.		
Tacks, of sorts, in weight	10 12	,,	,,
Nails in No. Clasp, 40-penny	22,000	,,	,,
Nails in No. Clasp, 30 ,,	29,250	,,	,,
Nails in No. Clasp, 20 ,,	50,400	,,	,,
Nails in No. Clasp, 10 ,,	45,500	,,	,,
Nails in No. Clasp, 8 ,,	40,000	,,	,,
Nails in No. Clasp, 6 ,,	44,000	,,	,,
Nails in No. Clout, 6 ,,	21,000	,,	,,
Nails in No. Clout, 4 ,,	22,000	,,	,,
Nails in No. Clout, 3 ,,	13,000	,,	,,
Nails in No. Clout, 2 ,,	43,000	,,	,,
Nails in No. Streaks, of sorts	8,500	,,	,,
	cwt. qrs. lbs.		cwt. qrs. lbs.
Nails in weight, Clasp, 40-penny	16 0 8	,,	10 2 24
Nails in weight, Clasp, 30 ,,	4 0 24	,,	,,
Nails in weight, Clasp, 20 ,,	10 3 0	,,	8 2 20
Nails in weight, Clasp, 10 ,,	2 1 8	,,	2 0 16
Nails in weight, Clasp, 8 ,,	3 2 8	,,	1 3 4
Nails in weight, Clasp, 6 ,,	2 2 0	,,	1 1 0
Nails in weight, Clout, 4 ,,	1 1 10	,,	0 3 26
Nails in weight, Clout, 3 ,,	0 0 25	,,	0 0 12½
Nails in weight, Clout, 2 ,,	0 2 14	,,	0 1 2
Tire nails, 24-pounder carriages	4,500	,,	3,380
Tire nails, 8-inch howitzers	1,200	,,	600
Tire nails, 6-pounders, heavy	1,400	,,	,,
Tire nails, 6-pounders, light	200	,,	,,
Spades	204	,,	50
Shovels	84	,,	20
Axes, Felling	204	,,	50
Axes, Broad	84	,,	20
Axes, Pick	204	,,	50
Hand Hatchets	200	,,	50
Hand Bill	204	,,	50
Spare helves, of sorts	300	,,	,,
Grindstones, with troughs	8	,,	2
Hand-barrows, double	20	,,	,,
Hand-barrows, single	80	,,	20
Saws, Sash	74	,,	24
Saws, Hand	100	,,	40
Saws, Pit	12	,,	3
Saws, Cross-cut	22	,,	4
Setters for ditto, dozens, Hand	100	,,	40
Setters for ditto, dozens, Pit	12	,,	3
Setters for cross-cut saws, dozens	24	,,	6

TABLE VI.—*continued.*

	Total sent from England.	Left at St. Sebastian.	Expended at the Siege.
Files for cross-cut saws, dozens, Sash	2	„	1
Files for cross-cut saws, dozens, Hand	100	„	40
Files for cross-cut saws, dozens, Pit	11	„	3
Files for cross-cut saws, dozens, Cross-cut	24	„	6
Pin mauls	7	„	„
Wood mauls	5	„	„
Linchpins	7	„	„
Camp colours	80	„	30
Oak skidding, 8 × 8 inches, feet, running	800½	„	185
Deals, feet, running, 3-inch	4,110	„	690
Deals, feet, running, 2 „	200	„	„
Deals, feet, running, 1½ „	424	„	112
Deals, feet, running, 1¼ „	168	„	56
Deals, feet, running, 1 „	404	„	108
Deals, feet, running, ¾ „	408	„	108
Deals, feet, running, ½ „	412	„	100
Plank, feet, superficial, Ash, 2½-inch	2,000	„	399
Plank, feet, superficial, Ash, 2 „	2,000	„	82
Plank, feet, superficial, Elm, 1½ „	2,000	„	1,000
Plank, feet, superficial, Elm, 1¼ „	2,000	„	995
Plank, feet, superficial, Elm, 1 „	1,995	„	1,000
Spare, in the rough, Spokes	850	„	231
Spare, in the rough, Bars, fore	473	„	44
Spare, in the rough, Bars, hind	397	„	60
Spare, in the rough, Bars, splinter	205	„	10
Spare, in the rough, Bars, sweep	48	„	12
Spare, in the rough, Bars, master	80	„	20
Spare, in the rough, Axletrees	25	„	5
Spare, in the rough, Naves	40	„	10
Spare, in the rough, Shafts, heavy	4	„	„
Spare, in the rough, Shafts, light	4	„	„
Spare, in the rough, Under-poles	40	„	10
Tail pieces	80	„	„
Guides, fore	19	„	5
Guides, hind	21	„	5
Axletree beds	40	„	10
Nose-bags	[illegible]30	„	„
Forage cords, sets	206	„	8
Shoeing tools, sets	2	„	2
Swingletrees	80	„	20

Collar-makers' Materials.

	Total sent from England.	Left at St. Sebastian.	Expended at the Siege.
Hides, Black, heavy	13	„	„
Hides, Black, light	14	„	„
Hides, Brown, heavy	8	„	„
Hides, Brown, light	8	„	„
Hides, Seat	5	„	½
Hides, White horse	7	„	„
Basils, dozens, black	28	„	„
„ „ brown	22	„	„

TABLE VI.—*continued.*

	Total sent from England.	Left at St. Sebastian.	Expended at the Siege.
Wax, lbs. Bees'	12	"	"
Wax, lbs. Black	26	"	"
Thread, lbs. Hemp	54	"	"
Thread, lbs. Collar	21	"	3
Thread, lbs. lb. Brown	13	"	"
Resin, lbs.	12	"	"
Pitch, lbs.	12	"	"
Bristles, oz.	31	"	"
Buckles, assorted, dozens	56	"	"
Does' hair, lbs.	252	"	"
Thongs, Throat	400	"	"
Thongs, Top	400	"	"
Thongs, Draw	400	"	"
Needles, Collar	210	"	"
Needles, Stitching	90	"	"
Needles, Saddle	50	"	"
Flock, lbs.	56	"	16
Awls, of sorts	200	"	"
Hafts, of ditto	74	"	"
Punches, sets	12	"	"
Rhand twine, lbs.	33	"	"
Whip-cord, lbs.	25	"	3
Brushes, Hand	25	"	"
Brushes, Soft	34	"	"
Brushes, Water	34	"	"
Tin pans for oil	34	"	"
Serge, yards	120	"	"
Spare.			
Bail hoops, 9-feet	200	"	50
Master bars	80	"	20
Swingletrees	200	"	"
Axletrees, bound off complete for 24-pounders	15	"	4
Ditto, ditto, 8-inch howitzers	2	"	"

EQUIPMENT, ENGINEER.—See 'SIEGE AND ENGINEER EQUIPMENT.'

EQUIPMENT, NAVAL.

The Tables to this article give the armament of the different classes of the ships of war in the British Service, with the stores supplied by the Ordnance Department. They are useful, and indeed necessary to that department on foreign stations, in order to make such a provision for the Navy abroad as may be required when vessels of war touch at those places.

The following memoranda, drawn up by Colonel Munro, Royal Artillery, and presented to a highly distinguished Naval Officer, Admiral Sir Benjamin Hallowell, at the Admiralty, in 1825, and subsequently to Captain the Hon. Sir Henry Duncan, it would appear, led to the equipment explained in Table I.: the Editors of the 'Aide-Mémoire' are indebted to that Officer for these memoranda, and the Service, in the event of a maritime war, will feel the effects of a system which will produce, no doubt, important results.

The author of this scheme states that in contemplating this arrangement he was induced to propose this particular piece of ordnance (the 32-pounder gun) as the maximum and only calibre adapted for the armament of ships of war, in considering the several naval actions where we had been successful, and where we had used the largest calibre, the 32-pounder gun of 56 cwt., as well as those frigate actions where we had been unsuccessful, and used the naval gun, the long 18-pounder; also that he had heard Naval Officers assert that our seamen would fire the 32-pounder lower-deck guns four or five times whilst the French fired their 36-pounders (equal to our 42-pounders) three times; and that our 18-pounder gun could not cope with the American 24-pounder long gun; and with the view of having one uniform calibre in each ship of war, submitted the following:

"Memorandum relative to a proposed and very superior Armament for the Navy, suggested in consequence of facts connected with the last war with America, and founded on a belief that our ships, in some instances, were lost entirely from the difference of metal between them and their antagonists.

"Woolwich, 1825. "ALEX. MUNRO."

"1st. There should be no different calibre in any ship. Every shot or shell should be applicable to any piece of ordnance in the ship.

"2nd. This may be most easily obtained by modifying the guns from the lower decks of the line-of-battle ships, in proportion, until reaching a scale established as a minimum for guns on the quarter decks or poops.

"3rd. That the calibre should be that of a 32-pounder.

"4th. That instead of the present 32-pounder carronade, guns constructed on the modified scale should be adopted, or carronades of a new construction with trunnions; but the carronade is altogether a most objectionable piece of ordnance.

"5th. That for the smallest class of line-of-battle ships, or frigates which now only carry 18-pounders on their main decks, modified 32-pounder guns (equal in weight, viz., 42 cwt., to the present 18-pounders) should be cast; and hollow shot or plugged 32-pounder shells should be used.

"6th. That instead of the 32-pounder carronades, with which our 18-gun brigs and vessels of that description are now armed, guns weighing about 25 cwt. should be used. That these guns should or might be fired with a charge of 4 lbs. of powder, and when near an enemy, with two hollow shots at each round.

"Twelve of the proposed modified 32-pounders, each weighing 25 cwt., would be little more than the same quantity of metal now on the deck of an 18-gun brig armed with the present carronades; but it is believed that with ten of such modified guns, capable of firing two hollow shots or shells in close action, or with a round of grape and round shot together, these brigs, then called *ten-gun* brigs, would be equal, if not superior, in force to what they now are. The men would have better quarters at their guns; and the brigs might be relieved from the weights of metal now near the stem and stern, by a different position of the five or six ports on a side, instead of nine or ten.

"The guns proposed are,

"First. The present 32-pounder; weight 57 cwt., charge 10 lbs.	When mounted on lower decks of line-of-battle ships.
"Secondly. Modified* 32-pounders; weight 42 cwt. (equal to present 18-pounder), charge 5 or 6 lbs.	Main decks and in frigates, and hollow shot when close, or charge equal to 1 round grape and 1 round shot.
"Thirdly. Second class modified* 32-pounders; weight 25 cwt., charge $3\frac{1}{2}$ or 4 lbs.	Quarter decks, forecastle of frigates and line-of-battle ships, decks of 18-gun brigs and all smaller vessels."

It may be assumed, therefore, that the principle laid down in the foregoing Memorandum has been happily adopted, by referring to Table I.; and thus the confusion incident to guns of several calibres being placed in one vessel avoided, and the power of the armament greatly increased.

It must be admitted that there is a maximum calibre at which the shot is capable of penetrating the sides of ships of war, and destroying everything it meets, combined with the facility of working the piece of ordnance adapted to naval armaments, and the armament of coast defences, and that is considered to be the 32-pounder gun, as preferable for broadside guns. The 42, 56, 68, and 84-pounder guns, no doubt valuable for special cases, will make a larger hole in the sides of a vessel, and a corresponding destruction; but as the weight and length are increased, so the celerity of fire decreases, and a number of men to work these heavy pieces of ordnance must be added.

It is therefore to be wished that these ponderous and unwieldy descriptions of ordnance should be limited in naval warfare to a few in each vessel. About one-tenth of the whole armament, as will be seen in Table I., is now established as a principle.

These remarks are induced from a desire evinced by some influential persons, of arming vessels of war with the 42-pounder gun. The French seem disposed to abandon their 36-pounder, and adopt the 30-pounder of 6·457 inches diameter, English measure.†

See 'Artillery' Tables A. B. C. D.

The Tables to the article 'Artillery' will give the weights and dimensions of the several pieces of ordnance now used in the armament of ships of war. Table II. of this article gives their ranges. It has been explained in 'Artillery' that the Ordnance Department supply all artillery stores, ammunition, and guns to the Navy, and hence the advantage to the Service generally for a perfect knowledge of the description and nature of these articles.

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* This 'Modification' to suit different vessels, or different decks in the same vessel, has been in some respects met by the introduction of Monk's A. B. C. 32-pounders,—and in others by the 24-pounder and 18-pounder 'bored up' to the same calibre. See 'Artillery' Table A.—*Editors.*

† Since these remarks were suggested, the 8-inch gun has been generally introduced into the Navy, in the proportion of one-tenth of the whole armament.

TABLE I.

Proportion of Ordnance to be issued to Her Majesty's Ships.

ORDNANCE.	Weight.	Length.	First-Rate. Classes. 120 Guns.	120 Guns.	116 Guns.	120 Guns (Old Class).	Second-Rate. Classes. 104 Guns (Old Class).	90 Guns.	90 Guns (Old Class).	80 Guns.	84 Guns (Old Class).	Third-Rate. Classes. 78 Guns.	70 Guns.	72 Guns.	Fourth-Rate. Classes. 60 Guns.	50 Guns.	50 Guns.	50 Guns (Old Class).	Fifth-Rate. Classes. 40 Guns.	36 Guns.	44 Guns.	42 Guns.	Sixth-Rate. 1st Class. 28 Guns.	26 Guns.	24 Guns.	26 Guns.	20 Guns.	Sixth-Rate. 2nd Class. 26 Guns.	26 Guns.	18 Guns.	18 Guns.	22 Guns.	Sloops. Classes. 18 Guns.	16 Guns.	14 Guns.	12 Guns.	12 Guns.	8 Guns.	8 Guns.	8 Guns.	Steamers.	Brigs. Classes. 6 Guns.	3 Guns.	No. of people required to work the Guns, &c. Men.	Boys as Powder-Men.
Guns.	Cwts.	ft. in.																								*																			
10-inch	87	9 4	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	2	,,	2	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	The Armaments of Steam Ships differ much and are very uncertain. 10-inch Guns and 68-Pounders of 95 cwt. are now used in all the larger vessels; the number suitable to the capability of the ship.	,,	,,	17	1
	84	9 4	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,		
8-inch	65	9 0	32	32	30	12	6	32	24	14	12	8	12	6	30	28	12	,,	,,	,,	,,	,,	,,	,,	10	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	14	1
	60	8 10	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	8	6	4	4	,,	2	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	13	1
	52	8 0	,,	,,	,,	,,	,,	,,	2	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	4	,,	2	,,	2	6	,,	,,	2	2	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	12	1
68-pounder	95	10 0	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	18	1
‡	56	9 6	34	32	30	24	24	34	42	18	22	24	16	22	2	2	20	,,	18	18	,,	,,	,,	,,	8	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	13	1
	50	9 0	6	,,	,,	30	,,	,,	,,	24	,,	,,	26	,,	,,	,,	,,	,,	,,	2	,,	,,	,,	,,	,,	,,	10	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	12	1
	50-48	8 0	,,	,,	,,	,,	28	,,	,,	,,	28	,,	,,	,,	,,	,,	,,	22	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	12	1
	45	8 6	,,	8	,,	,,	6	,,	,,	,,	,,	30	,,	,,	20	20	18	4	,,	,,	4	4	,,	,,	,,	,,	,,	2	,,	2	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	11	1
32-pounder	42	8 0	34	34	40	40	,,	24	22	24	6	6	16	32	,,	,,	,,	,,	16	,,	,,	,,	,,	2	,,	22	,,	,,	,,	,,	16	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	10	1
	40	7 6	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	24	,,	20	16	,,	,,	,,	,,	,,	14	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,		
	39	7 6	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	24	,,	,,	,,	,,	,,	,,	2	,,	,,	2	2	2	2	2	,,	,,	,,	,,		,,	1		
	32	6 6	,,	,,	,,	,,	30	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	2	2	2	,,		2	2	9	1
	25	6 0	14	14	16	,,	,,	,,	,,	,,	,,	,,	,,	,,	8	,,	,,	16	,,	12	,,	,,	6	6	4	,,	2	16	,,	,,	,,	,,	16	14	12	10	10	6	,,	,,		,,	,,	8	1
	25	5 4	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	20	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,		
18-pounder	20	6 0	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	2		,,	,,	7	1
	15	5 6	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	6		,,	,,	6	1
6-pounder, Brass	6†	5 0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	3	1
Carronades.																																													
8-inch	36	5 4	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	2	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,		
32-pounder	17	4 0	,,	,,	,,	14	10	,,	,,	,,	16	10	,,	12	,,	,,	,,	,,	,,	,,	12	10	,,	,,	,,	,,	,,	6	4	,,	,,	20	,,	,,	,,	,,	,,	,,	6	,,		,,	,,	7	1
18-pounder	10	3 4	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		4	,,	3	1
Mortars.			No proportion. Issued only by special order.																																										
Howitzers.																																													
24-pounder	13†	4 8½	2	2	2	2	2	2	2	2	2	2	2	2	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	6	1
12-pounder Heavy	10†	4 7	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	2	2	2	2	2	2	2	2	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,		,,	,,	4	1
12-pounder Light	6¼†	3 9¼	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1		1	1	3	1

* Armament for Quarter-deck and Forecastle not settled. † Boat Guns.

	cwt.	ft. in.	
‡ 32-pounder . . .	58	9 6	To be introduced gradually into the Naval Service in lieu of the 32-pounder 56 cwt. guns.

TABLE II.

Ranges of the New Naval Guns.

	Weight.	Length.	Charge.	P. B.	2°	3°	4°	5°	7°	9°	12°	15°
	cwt. qr. lbs.	ft. in.	lbs.	yards.	yards.	yards.	yards.	yards.	yards.	yards.	yards.	yards.
10-inch gun	85 1 7	9 4	12	287	1033	1282	1489	1642	2097	2579	3028	3456
8-inch gun	110 0 0	10 6	18	450	1313	1608	1926					
Ditto	65 2 26	9 0	10	470	1133	1323	1602	1922	2246	2577	3016	3370
32-pounder (Monk)	49 1 8	9 0	8	From 380 to 420 yards, according to the charge.	1163	1443	1662	1940	2231	2544	3090	3513
"	44 2 0	8 6	7		1124	1440	1731	1934	2242	2498	3175	3391
"	"	"	6		1139	1374		1900				
"	40 3 22	8 0	8		1183	1486	1607	1703	2372	2472	2919	3284
"	"	"	6		1185	1476	1792	1894	2305	2514		3546

For the ranges and charges, &c. of the bored-up guns, see 'Artillery' Table F.

Memorandum.—For comparison with the above—

	Weight.	Length.	Charge.	P. B.	2°	3°	4°	5°	7°	9°	12°	15°
32-pounder (old)	56 0 0	9 6	10	400	1130			1964			3030	

TABLE III.

Ordnance Naval Stores.

SHIP ORDNANCE.	RATES. First.	RATES. Second.	RATES. Third.	RATES. Fourth.	RATES. Fifth.	RATES. Sixth.	Sloops and Bombs, 16 guns and upwards.	Steamer Sloops.	Brigs under 16 guns.	Schooners, Cutters, &c.	Packets, 4 guns and upwards.	Steamers under 4 guns.
Cartridge cases, leather	Four to each gun and carronade.											
Chisels, steel, for removing tampeons	One to each gun and carronade.											
Crows, iron, { 5½ feet, for 18-pounder and upward. 4½ feet, for 12-pounder and below	One to every five guns for paddle steamers; one to every six guns for all other vessels.											
Elevating screws, with caps	One for each carronade, and one each for 32-pounder guns from 32 cwt. to 25 cwt., and 18-pounder guns from 20 cwt. to 15 cwt. One for each howitzer and gun-boat and field carriage.											
Formers, for making wads	One to every seven guns and carronades; when less than seven, of any calibre, one former allowed.											
Gauges (high gauge) for shot	One for each calibre of guns and carronades, on board the ship, and for boats.											
Hammers, direct-action, for detonating tubes	One to each gun; one spare to every four guns for paddle steamers, and one spare to every five guns for all other vessels.											
Handspikes, 6 feet, common	Three to each gun on common or Hardy's slides; four for pivot guns lighter than 52 cwt.											
Ladles with staves, for guns	One to every seven guns, or less number than seven guns, of each calibre.											
Lintstocks, with cocks	One to each field carriage.											
Mallets, for removing tampeons	One to each gun and carronade.											

TABLE III.—*continued.*

SHIP ORDNANCE.	RATES. First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Sloops and Bombs, 16 guns and upwards.	Steamer Sloops.	Brigs under 16 guns.	Schooners, Cutters, &c.	Packets, 4 guns and upwards.	Steamers under 4 guns.	
Powder horns	One to every four guns and carronades.												
Priming irons	Five to every four guns and carronades.												
Rammers with staves, for guns	Five to every four guns; for pivot guns, two to each, fore and aft.												N. B. For carronades the rammer head is fixed on the sponge stave.
Sights, with pins and screws, Miller's pattern with covers	Eleven sights to every ten guns and carronades, and one additional fixing screw to each sight.												
Sponges, with caps of painted canvas, guns, with ropes and rammer heads	Five to four guns on any deck of line-of-battle ships having hanging ports, in addition to the sponges with staves.												
Sponges, with caps of painted canvas, guns, with staves, without rammer heads	Five to every four guns, and two to each pivot gun, fore and aft.												
Sponges, with caps of painted canvas, carronades, with staves and rammer heads	Five to every four carronades.												
Spikes, for howitzers, common	Two to each piece.												
Spikes, for howitzers, spring	One to each piece.												
Tampeons	Two to each gun and carronade.												
Vent-bits	One to every two guns and carronades for ships; one to each piece of ordnance for the boats.												
Wadhooks, with staves, without rammer heads	One to each gun and carronade, and one spare to every seven (or less number) of the same calibre; two to each pivot gun, fore and aft. When six (or a less number of) pivot guns of the same calibre, two spare.												
Wrenches for sights	One to every ten sets of sights. Any ship having sights allowed one wrench.												

TABLE IV.

General Stores and Spare Articles.

GENERAL STORES, &c.	RATES. First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Sloops and Bombs, 16 guns and upwards.	Steamer Sloops.	Brigs under 16 guns.	Schooners, Cutters, &c.	Packets, 4 guns and upwards.	Steamers, under 4 guns.	
Accounts	To each ship or vessel, being for three years' supply.												N.B. Detail unnecessary for military purposes.
Adzes, copper	One to each ship, if the powder be shipped in barrels.												
Armourers' tools, materials, &c.: Set, in a chest, with padlock and key	1	1	1	1	1	1	1	1	1	"	"	"	
Borax, ounces	"	"	"	"	"	"	"	"	"	4	4	4	These articles are included in the "set" for larger vessels.
Drill Bits	"	"	"	"	"	"	"	"	"	2	2	2	
Emery, fine, lbs.	"	"	"	"	"	"	"	"	"	1	1	1	
Files, bastard, flat, 9 inch	"	"	"	"	"	"	"	"	"	2	2	2	
Files, bastard, half-round, 6 "	"	"	"	"	"	,	"	"	"	1	1	1	
Files, bastard, round, 6 "	"	"	"	"	"	"	"	"	"	1	1	1	
Files, rough, flat, 12 "	"	"	"	"	"	"	"	"	"	2	2	2	
Files, rough, half-round, 10 "	"	"	"	"	"	"	"	"	"	1	1	1	
Files, rough, round, 9 "	"	"	"	"	"	"	"	"	"	1	1	1	
Files, rough, three-square, 10 "	"	"	"	"	"	"	"	"	"	1	1	1	
Files, smooth, flat, 9 "	"	"	"	"	"	"	"	"	"	1	1	1	
Files, smooth, half-round, 6 "	"	"	"	"	"	"	"	"	"	1	1	1	
File handles	"	"	"	"	"	"	"	"	"	4	4	4	
Hammers, riveting, 24 oz.	"	"	"	"	"	"	"	"	"	1	1	1	
Nails, musket, breech	"	"	"	"	"	"	"	"	"	4	4	4	
Nails, musket, lock	"	"	"	"	"	"	"	"	"	12	12	12	
Nails, musket, side	"	"	"	"	"	"	"	"	"	4	4	4	
Sal ammoniac, ounces	"	"	"	"	"	"	"	"	"	4	4	4	
Saws, slitting	"	"	"	"	"	"	"	"	"	1	1	1	
Screw-drivers, 4-inch	"	"	"	"	"	"	"	"	"	1	1	1	
Spelter, ounces	"	"	"	"	"	"	"	"	"	4	4	4	
Tools, for cannon locks	"	"	"	"	"	"	"	"	"	1	1	1	
Vices, hand	"	"	"	"	"	"	"	"	"	1	1	1	
Wiping rods, musket	"	"	"	"	"	"	"	"	"	1	1	1	
Wiping rods, pistol	"	"	"	"	"	"	"	"	"	1	1	1	

TABLE IV.—*continued.*

GENERAL STORES, &c.	RATES. First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Sloops and Bombs, 16 guns and upwards.	Steamer Sloops.	Brigs under 16 guns.	Schooners, Cutters, &c.	Packets, 4 guns and upwards.	Steamers under 4 guns.	
Barrels, budge, with 4 copper hoops	3	2	2	2	1	1	1	1	1	1	1	1	
Baskets, half-bushel	12	10	10	8	6	3	2	2	2	1	1	1	
Brooms, hair, magazine, long	2	2	2	2	1	1	1	1	1	,,	,,	,,	The rule is, one of each for each magazine.
Brooms, hair, magazine, short	2	2	2	2	1	1	1	1	1	1	1	1	
Can-hooks, copper, pairs	4	4	4	4	2	2	2	2	,,	,,	,,	,,	At the option of the Captain, for small vessels.
Chests, with padlock and key to each, for laboratory stores, &c.	1	1	1	1	1	1	1	1	1	,,	,,	,,	
Drivers, wood, shod with copper	Two to each ship, if the powder be shipped in barrels.												
Drums, wood, with sticks	2	2	2	2	1	1	1	1	1	1	1	1	
Drum, cords	Two for each drum.												
Drum, heads	Four for each drum.												
Drum, snares	Two for each drum.												
Funnels, copper, for filling shells	One to each ship having shells allowed.												
Funnels, copper, for filling cartridges, &c.	Two to each magazine.												
Hammer, claw	One to each ship.												
Hides, tanned	6	6	6	4	3	3	1st Class 2, 2nd ,, 1	2	1	1	1	1	
Keys, copper, for opening barrels	Six to each magazine, and one for detonating tube box.												
Knives, small, laboratory	3	3	3	3	3	2	2	2	2	1	1	1	
Knives, metal, magazine	1	1	1	1	1	1	1	1	1	1	1	1	
Lanthorns, dark	1	1	1	1	1	1	1	1	1	1	1	1	
Lanthorns, Muscovy	2	2	2	2	1	1	,,	1	,,	,,	,,	,,	
Lanthorns, tin	4	3	3	3	2	2	2	2	1	1	1	1	
Luting for barrels and cases	Half an ounce to each barrel and case.												
Match, slow, cwt.	1	1	1	¾	¾	¾	½	1	½	¼	¼	¼	
Measures, copper, for powder, 4, 2, and 1 lb. / 8, 4, 2, and 1 oz.	One set to each magazine for 5th-rates and smaller vessels.												

Nails, rose-head, for packages, No. 16	250	200	200	140	130	100	100	100	100	„	„	„
„ 14	500	400	400	250	250	250	150	200	150	„	„	„
„ 13	1250	1000	1000	750	700	600	300	300	300	„	„	„
Needles, stitching	40	40	40	30	30	20	12	18	10	6	6	6
Oil, olive, imperial gallons	10	10	9	6	5	5	3	5	2	1	1	1
Scissors	2	2	2	2	2	2	2	2	2	1	1	1
Shovels, copper, magazine	One to each magazine.											
Slippers, leather, magazine, pairs	15	13	13	9	8	6	3	3	3	2	2	2
Snuffers, copper	One to each light room.											
Vices, copper	One to each ship, if the powder, &c. be shipped in barrels.											
Whiting, for putty, &c.	Two pounds to each gun and carronade.											
Worsted	One ounce to each gun and carronade.											
Wrenches, square-headed bolts	Two to each ship having guns and carronades mounted on jamming carriages.											
SPARE ARTICLES.												
Axletrees, iron	Two to each steam vessel having 10-inch or 32-pounder guns with compressing carriages.											
Axletrees, wood, common carriage, fore / hind	One of each to every eight (or less number of) carriages.											
Beds, for carriages, elevating, bottom	One spare to each ship.											
Beds, for carriages, common	One to every eight (or less number of) carriages.											
Bolts, fighting or housing	One to every eight (or less number of) slides.											
Coins, for carriages, elevating, bottom	One to each carriage.											
Coins, for carriages, ship, common, large / small	One to every eight (or a less number of) carriages for guns.											
Compressors	One to each carriage when not more than two carriages, and three to any number not exceeding eight carriages.											

TABLE IV.—*continued.*

<table>
<tr><th rowspan="2">SPARE ARTICLES.</th><th colspan="6">RATES.</th><th rowspan="2">Sloops and Bombs, 16 guns and upwards.</th><th rowspan="2">Steamer Sloops.</th><th rowspan="2">Brigs under 16 guns.</th><th rowspan="2">Schooners, Cutters, &c.</th><th rowspan="2">Packets, 4 guns and upwards.</th><th rowspan="2">Steamers under 4 guns.</th></tr>
<tr><th>First.</th><th>Second.</th><th>Third.</th><th>Fourth.</th><th>Fifth.</th><th>Sixth.</th></tr>
<tr><td>Forelock, keys, iron</td><td colspan="12">Six to each spare axletree.</td></tr>
<tr><td>Forelock, keys, metal</td><td colspan="12">One to each carriage, for all guns.</td></tr>
<tr><td>Handspikes, with rollers</td><td colspan="12">Three for two pivot carriages with Gordon's rollers, and two to each carriage when not so fitted.</td></tr>
<tr><td>Handspikes, 7-feet, common</td><td colspan="12">Four to each carriage, for pivot guns of 52 cwt. and upwards.</td></tr>
<tr><td>Linchpins, iron, common</td><td colspan="12">Two to each spare axletree; one for each field carriage.</td></tr>
<tr><td>Plugs, for sockets</td><td colspan="12">The number of plugs and sockets cannot be correctly stated, the number varying according to the construction of the ship and fittings of the deck.</td></tr>
<tr><td>Screws, jamming, carronade
Screws, jamming, gun</td><td colspan="12">One to every eight (or less number of) carriages fitted with Hardy's slides.*</td></tr>
<tr><td>Sockets, metal</td><td colspan="12">The number of sockets cannot be correctly stated, the number varying according to the construction of the ship and fittings of the deck.</td></tr>
<tr><td>Trucks for carriages, common, fore
Trucks for carriages, common, hind</td><td colspan="12">One of each to every eight (or less number of) common carriages.</td></tr>
<tr><td>Trucks for carriages, elevating, &c., bottom</td><td colspan="12">One 12-pounder (fore) and one 6-pounder (fore) to each ship.</td></tr>
<tr><td>Washers, iron</td><td colspan="12">One for each field carriage.</td></tr>
</table>

* This description includes 32-pounders of 25 cwt. and 18-pounder guns, according to the new proportions.

TABLE V.—*Ammunition for Ship Ordnance.*

AMMUNITION FOR SHIP ORDNANCE.			RATES. First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Sloops and Bombs, 16 guns and upwards.	Steamer Sloops.	Brigs under 16 guns.	Schooners, Cutters, &c.	Packets, 4 guns and upwards.	Steamers under 4 guns.	Charges. Distant.	Full.	Reduced.	
Bearers for shot			Two to each gun of 10-inch, and 68 pounders.															
Blue lights			24	24	24	24	24	24	16	16	16	16	16	16				To flag-ships and broad pennants (Commodores), twelve additional allowed.
Cartridges, flannel, filled with powder, ship's establishment,	carronade	Pivot													„	180	„	
		Side													„	80	„	
	gun	Pivot: 10-inch													„	180	„	
		Pivot: 68-pounder													120	60	„	
		Pivot: 8-inch, 65 and 60 cwt.													120	„	60	
		Pivot: 8-inch, 52 cwt.													„	120	60	
		Pivot: 32-pounder, 56 cwt.													80	60	40	
		Pivot: All other 32-pounders and 18-pounders, 22 and 20 cwt.													„	120	60	
		Pivot: 18-pounder, 15 cwt.													„	„	180	
		Side: 10-inch													„	100	„	
		Side: 8-inch, 65 or 60 cwt.													60	„	20	
		Side: 8-inch, 52 cwt.													„	60	20	
		Side: 32-pounder, 56 cwt.													50	10	20	
		Side: All other 32-pounders and 18 pounders, 22 and 20 cwt.													„	60	20	
		Side: 18-pounder, 15 cwt.													„	„	80	
service in boats,	howitzers, each		438	348	348	321	321	348	201	*	201	201	201	201				
	gun, 6-pounder, $1\frac{1}{2}$ lb. each		66	66	66	66	66	1st cl. 66	„	„	„	„	„	„				
short practice, 4 oz. each			1020	1020	840	720	360	120	„	120	„	„	„	„				
empty, ship's establishment,	carronade		Twenty to each carronade, full charge.															
	gun		Thirty to each gun above 32-pounders 56 cwt., except 8-inch, in proportions of												„	15	15	To guns *not* allowed distant charges.
															$7\frac{1}{2}$	$7\frac{1}{2}$	15	To guns allowed distant and reduced charges.
			Twenty to each gun (8-inch and under 32-pounders 56 cwt.), in proportions of												5	10	5	
															„	10	10	To guns *not* allowed distant charges, except 8-inch 52 cwt., which have 15 for full, and 5 for reduced charges.
															„	20	„	To guns *not* allowed distant or reduced charges.
	carronades		Twenty to each												„	20	„	

Memorandum.—If a ship cannot stow the whole of her Stores here regulated, the Captain is to apply to the Admiralty, who will communicate with the Board of Ordnance thereon.

* One to each shot and shell, according to armament.

TABLE V.—*continued.*

AMMUNITION FOR SHIP ORDNANCE.	RATES. First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Sloops and Bombs, 16 guns and upwards.	Steamer Sloops.	Brigs under 16 guns.	Schooners, Cutters, &c.	Packets, 4 guns and upwards.	Steamers under 4 guns.	
Powder, in flannel bags, containing 15 lbs. each, for ship's establishment	Twenty rounds for each gun (excepting pivot guns, which have 30); of full charge for carronades and 8-inch guns, and of the reduced charge for all other guns.												
Portfires, for firing rockets, &c.	14	14	14	14	14	14	10	10	10	10	10	10	To flag-ships and broad pennants (Commodores), double supply allowed.
Portfire sticks	2	2	2	2	2	„	„	„	„	„	„	„	
Rockets, with sticks, Congreve's, 24-pounder	60	60	60	60	60	60	„	„	„	„	„	„	Not issued, except by express order.—*Vide* Admiralty Regulation.
Rockets, with sticks, Congreve's, 12 „	„	„	„	„	„	„	36	36	36	36	36	36	
Rockets, with sticks, signal, 1 lb. „	6	6	6	6	6	6	3	3	3	3	3	3	To flag-ships and broad pennants (Commodores), double supply allowed.
Rockets, with sticks, signal, ½ lb. „	18	18	18	18	18	18	9	9	9	9	9	9	
Machines or tubes, for firing rockets, Congreve's	Two to each ship, when the rockets are supplied.												
Machines or tubes, for firing rockets, signal, with detonating hammer	One to each ship.												

	Number per gun or carronade. Sailing vessels.	Steamers.	Sailing vessels and screw steamers.		
Shells filled with powder, and fixed to wood bottoms. All bow and stern pivot guns	60	60			
10-inch side guns	40	40			
8-inch side guns and carronades, 1st six	40	40			
8-inch side guns and carronades, 2nd six	20	20			
8-inch side guns and carronades, Remaining number	10	10			
32-pounder side guns and carronades in paddle steamers	–	10			
For two 32-pounder guns in sloops and brigs not having guns of a higher calibre	30	–			
Ditto in frigates	40	–			

Memorandum.—When vessels cannot stow their full proportion of filled, empty ones are to be supplied to make up the number allowed, without boxes, but with the proper proportion of fuzes and quantity of powder for filling them.

When the store of Moorsom's fuzes will admit of an extensive supply, the fuzes will be issued in the following proportions.*

Fuzes.

Moorsom's	3 to 4 shells.				
3-inch	1 to 4 shells.				
4-inch spare	1 to every 2 shells with 3-inch fuzes in steamers and for pivot guns of sailing vessels. One to every 3 shells with 3-inch fuzes for all other guns of sailing vessels.				
			With short range fuzes.	With Moorsom's fuzes.	With 3-inch fuzes.
Shells filled with powder, &c., in addition to the above. — 1st rates	–	–	150	150	150
2nd rates, 'Princess Charlotte' class	–	–	150	150	150
Other 2nd rates	–	–	100	100	100
3rd rates	–	–	100	100	100
4th rates	–	–	60	60	60
5th rates	–	–	50	50	50
6th rates	–	–	35	35	35
All sloops	–	–	25	25	25
Shot — All bow and stern pivot guns	120	120			
10-inch side guns	60	60			
8-inch side guns and carronades — 1st six	40	40			
2nd six	60	60			
Remaining number	70	70			
32-pounder side guns and carronades	80	70			
All other side guns and carronades below 32-pounders	80	80			

Memorandum.—The number of 8-inch shells for any steamer is not to exceed 500.

Memorandum.—Vessels commanded by Officers below a Commander are not to have shells with Moorsom's fuzes.

Memorandum.—If any ship carrying carronades can conveniently stow a greater proportion of round shot, an additional number will be supplied on application to the Ordnance Storekeeper at the Port.

Shells not being allowed to carronades and guns of a lower calibre than 32-pounders, these descriptions of ordnance will be supplied with an additional number of shot equal to the number of shells above given.

* In the mean time the issues are made as follows:—Moorsom's 1 to 4 shells, 3-inch 3 to 4 shells, except for 32-pounder shells in the three last columns.

TABLE V.—*continued.*

Ammunition for Ship Ordnance.	Rates. First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Sloops and Bombs, 16 guns and upwards.	Steamer Sloops.	Brigs under 16 guns.	Schooners, Cutters, &c.	Packets, 4 guns and upwards.	Steamers under 4 guns.	
Shot, grape, ship's establishment, for 32-pounder guns and less calibre	One to each gun on lower and middle decks; three to every other gun.												
Shot, grape in tin cases, ship's establishment	Three to each carronade and 32-pounder gun of 25 cwt.												
Shot, round, boat service, gun, 6-pounder brass	30	30	30	30	30	1st Cl. 30	„	„	„	„	„	„	
Shot, round, short practice guns, brass, 6-pounder	1020	1020	840	720	360	120	„	„	„	„	„	„	
Shot, tin case, ship's establishment, carronades	Five to each carronade.												
Shot, tin case, ship's establishment, guns, 32-pounder, and less calibre	N. B.—None to the lower and middle deck guns; two per gun on main deck; three for every other gun, except 25 cwt. guns.												
Shot, tin case, boat service, guns, 6-pounder brass	36	36	36	36	36	36	„	„	„	„	„	„	
Tubes, detonating	One hundred and sixty to each gun and carronade; one hundred and fifty to each life buoy fitted with detonating hammers.												
Tube boxes, with straps	Two to each gun and carronade.												
„ magazines, copper, portable, Captain Fead's pattern	„	„	„	„	„	2	2	„	2	2	„	„	For the two aftermost, or stern guns, or carronades, in each ship or vessel.
Wadhooks	One to each gun, and one spare to every seven or less number; for two pivot guns, one fore and one aft, one spare to each gun.												
Wrenches, for fuzes of shells	Two to each gun having shells allowed; and the following in addition for 32-pounder shells for close action, viz.:												
Sailing vessels	50	34*	34	20	17	12	9						
Steamers	50	34	34	20	9	9	9						

* 'Princess Charlotte' Class, 50.

TABLE VI.—*Small Arms and Ammunition.*

SMALL ARMS AND AMMUNITION.	RATES. First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Sloops and Bombs, 16 guns and upwards.	Steamer Sloops.	Brigs under 16 guns.	Schooners, Cutters, &c.	Packets, 4 guns and upwards.	Steamers under 4 guns.	
Axes, pole	30	30	30	25	25	20	12	20	10	5	5	5	
Boxes for cartridges, musket	2	2	2	2	2	1	1	1	1	1	1	1	
Boxes for cartridges, pistol	1	1	1	1	1	1	”	1	”	”	”	”	
Cartouch boxes with belts, musket	”	”	”	”	”	”	”	”	”	”	”	”	One for each musket and pistol supplied.
Cartouch boxes with belts, pistol	”	”	”	”	”	”	”	”	”	”	”	”	
Frogs for bayonets, musket	”	”	”	”	”	”	”	”	”	”	”	”	Equal to the number of musket bayonets.
Muskets, percussion, rifled, complete	25	25	20	17	15	10	Sloops, 6; smaller vessels, 3. In lieu of an equal number of the other kind, as fast as the store will admit.						
” ” common, complete — sailing vessels and screw steamers	Equal to ⅓rd of full complement of men, including Marines. Vessels with 100 men and under, equal to ½ of full complement, including Marines.												
” ” common, complete — paddle steamers	Equal to ¼ of full complement of men, including Marines.												
Materials for making up blank cartridge on board, for 3 years' consumption, 180 rounds per man. — paper, sheets, purple	Nine.												
— powder, F. G.	lbs. 2, oz. 7, dwts. 6												
— thread, Dutch	lbs. 0, oz. 0, dwts. 7½												
Cartridges, ball, pistol, for exercise and practice	For half the Seamen, four rounds per man every six months.												
Pistols with rammers	90	90	78	60	60	46	30	30	16	16	16	16	
Pikes, strong	150	150	150	120	90	75	60	60	53	30	30	30	
Swords with scabbards and belts	”	”	”	”	”	”	”	”	”	”	”	”	Equal to half the full complement of men.
For Service.													
Cartridges, ball, musket, common and rifled	”	”	”	”	”	”	”	”	”	”	”	”	60 rounds per musket, including Marines.
Cartridges, ball, pistol	”	”	”	”	”	”	”	”	”	”	”	”	30 rounds per pistol.
For Practice.													
Cartridges, ball, musket, rifled	”	”	”	”	”	”	”	”	”	”	”	”	240 rounds per musket.
Cartridges, ball, musket, common	”	”	”	”	”	”	”	”	”	”	”	”	180 rounds do.
Cartridges, ball, pistol	”	”	”	”	”	”	”	”	”	”	”	”	50 rounds per pistol.
For Exercise and Practice for 3 years.													
For making up blank cartridges for muskets. formers, wood, musket	20	18	18	18	18	14	9	9	9	9	9	9	
funnels, copper	3	3	3	3	3	3	2	2	2	2	2	2	
measures, copper, musket, 3½ drams	3	3	3	3	3	3	2	2	2	2	2	2	
Caps, copper	Equal to the number of cartridges, and one-third in addition for service, one-fourth in addition for practice, and one-tenth in addition for blank cartridges.												
Nipples, musket	One to every six muskets.												
Nipples, pistol	One to every six pistols.												
Wrenches, percussion, triarmed	One to every eighteen pistols and muskets.												

TABLE VII.—*Packages.*

PACKAGES.	RATES. First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Sloops and Bombs, 16 guns and upwards.	Steamer Sloops.	Brigs under 16 guns.	Schooners, Cutters, &c.	Packets, 4 guns and upwards.	Steamers under 4 guns.	
Bags, flannel, to hold 15 lbs. of powder	Sufficient for the powder (not filled into cartridges) for guns, carronades, and small arms.												
Baskets, for covering bottles of glass	One to each.												
Baskets, for covering bottles of stone	One to each.												
Bottles, glass	Sufficient for the oil, &c.												
Bottles, stone	Sufficient for the oil, &c.												
Bottles, tin	Sufficient for the oil, &c.												
Boxes for lead ball, or shot, musket	Sufficient for the shot and shells of each description.												
Boxes for lead ball, or shot, pistol	Sufficient for the shot and shells of each description.												
Boxes for shot, guns, grape	Sufficient for the shot and shells of each description.												
Boxes for shot, guns, tin case	Sufficient for the shot and shells of each description.												
Boxes for shot, carronades, grape in tin cases	Sufficient for the shot and shells of each description.												
Boxes for shot, carronades, tin case	Sufficient for the shot and shells of each description.												
Boxes for shells and 32-pounders	Sufficient for the shot and shells of each description.												
Casks, or kegs	Sufficient for the whiting, &c.												
Cases, lined with metal, whole	Sufficient to contain the filled cartridges for the guns and carronades, and for muskets and pistols; also for the whole of the powder in flannel bags, for guns, carronades, and small arms. N.B.—Signal rockets are packed in half cases.												Dell's metal cases are to be used for steamers instead of metal lined.
Cases, lined with metal, half													
Cases, lined with metal, quarter													
Cases, packing, of sorts	Sufficient to contain the empty cartridges, and laboratory small stores, &c.; also for Congreve's rockets, when embarked.												

Note.—Tables IV. V. VI. and VII. of 'Equipment, Naval,' are now in course of re-arrangement, and will, when sanctioned by authority, be inserted.

EQUIPMENT, AMERICAN,* for Trains of Artillery,—Armament of Fortifications,—Field Train,—as prescribed by the Secretary at War of the United States.

FIELD TRAIN.

Ordnance.

The proportion of artillery to other troops varies generally between the limits of 1 and 3 pieces to 1000 men, according to the force of the army, the character of the troops of which it is composed, the force and character of the enemy, the nature of the country which is to be the theatre of war, and the character and objects of the war.

Similar considerations must regulate the selection of the kinds of ordnance, and the proportions of the different kinds in the train.

The following principles may be observed in ordinary cases:

$$2 \text{ pieces to 1000 men} \begin{cases} \frac{2}{3} \text{ guns, of which} \begin{cases} \frac{1}{4} \text{ are 12-pounders,} \\ \frac{3}{4} \text{ are 6-pounders,} \end{cases} \\ \frac{1}{3} \text{ howitzers, of which} \begin{cases} \frac{1}{4} \text{ are 24-pounders,} \\ \frac{3}{4} \text{ are 12-pounders,} \end{cases} \end{cases}$$

distributed as follows:

For the Infantry: 1 piece to 1000 men,—6-pounder guns and 12-pounder howitzers, in batteries of foot artillery.

For the Cavalry: 2 pieces to 1000 men,—6-pounder guns and 12-pounder howitzers, in batteries of horse artillery.

For the Special and General Parks of Reserve:

$$1 \text{ piece to 1000 men} \begin{cases} \frac{1}{2} \text{ in 12-pounder batteries of foot artillery,} \\ \frac{1}{3} \text{ in 6-pounder ditto ditto,} \\ \frac{1}{6} \text{ in 6-pounder batteries of horse artillery.} \end{cases}$$

Ammunition for Cannon.

Two hundred rounds to each piece, both of the reserves and of the active batteries.

The ammunition which cannot be carried in the caissons attached to the pieces will be kept in boxes with the reserves.

Proportion of the different kinds of Ammunition and other Supplies.

Kind.	For Guns. 12-prs.	For Guns. 6-prs.	For Howitzers. 24-prs.	For Howitzers. 12-prs.	
Strapped shot, fixed	76	70	–	–	For 100 rounds.
Canisters, fixed	12	20	–	–	
Strapped shells	–	–	52	48	
Spherical case-shot, strapped	12	10	35	40	
Canisters with sabots	–	–	13	12	
Cartridges, large charge (spare)	6	4	8	6	
Cartridges, small charge	12	10	100	100	
Fuzes	Twice the number of shells and spherical case-shot.				
Portfires	1 to 5 rounds.				
Tubes	½ more than the number of rounds.				
Slow-match	1 yard to 5 rounds.				
Quick-match	¼ yard to each spherical case-shot.				
Bursters	1 to each shell and spherical case-shot.				

* Ordnance Manual, published by authority of the American Government.

Additional supplies of ordnance and ordnance stores are placed in convenient dépôts, according to circumstances.

Ammunition for Small Arms.

One hundred rounds to each man; of which, for the musket, 40 rounds are in the cartridge box, 60 in the parks of reserve. In the same proportion for other small arms.

Five flints to 100 rounds.

Percussion caps for carbines, half more than the number of cartridges.

Composition of a Battery on the War Establishment.

	Kind of Battery.	12-pr.	6-pr.
Guns	12-pounders mounted	4	–
	6-pounders do.	–	4
Howitzers	24-pounders do.	2	–
	12-pounders do.	–	2
	Total number of pieces mounted	6	6
Carriages.	Gun carriages (spare)	1	1
	Caissons	12	6
	Forges (1 for repairs and 1 for shoeing)	2	2
	Battery waggons (1 for repairs, 1 for harness)	2	2
	Total number of carriages	17	11

Implements and Equipments for each Gun Carriage.

2 Gunner's haversacks.
1 Tube pouch.
1 Portfire case.
2 Thumbstalls.
1 Priming horn.
1 Prolonge.
1 Vent-cover and strap.
1 Lintstock.
1 Portfire stock.
1 Priming wire.
1 Fuze auger.
1 Fuze saw.
1 Fuze sett.
1 Vent-punch.
1 Gunner's gimlet.
1 Tangent scale.
1 pair Portfire cutters.
2 Sponges and rammers.
2 Sponge-covers.
½ Worm and Staff.
2 Handspikes.
1 Sponge bucket.
1 Tow-hook.
1 Fuze rasp.
1 Fuze mallet.
1 Shell plug-screw.

For each Howitzer Carriage (additional).

1 Fuze extractor.
1 Copper funnel.
1 Gunner's quadrant.
1 8-oz. Powder measure.

For each Caisson.

1 Felling-axe.
1 Shovel.
1 Pick.
1 Spare pole (one-half of them ironed).
1 Spare wheel, to each caisson of the reserves.
1 Spare handspike.
1 Tar bucket.
3 Tow-hooks.

For each Forge.

1 Water bucket.
1 Shovel.

Draught Horses.—6 to a battery waggon and 12-pounder gun carriage,—4 to other carriages—$\frac{1}{12}$th spare.

Harness,—corresponding with the number of horses to the carriages.

The equipments required for the immediate service of a piece are carried, on the march, in the ammunition chest of the limber.

SIEGE TRAIN.

The number and kind of cannon for a siege train must be determined by the circumstances of each case; but the following general principles may be observed in assigning the proportion of different kinds and calibres, and the relative quantity of other supplies, for a train of 100 pieces of ordnance.

Cannon.

Guns	24-pounder, about	one-third of the whole number		32	100
	18-pounder, „	one-tenth	„	10	
	12-pounder, „	one-tenth	„	10	
Howitzers	8-inch siege, „	one-eighth	„	13	
Mortars	10-inch siege, „	one-seventh	„	14	
	8-inch siege, „	one-fourteenth	„	7	
Stone mortars	„	one-seventh	„	14	
Coehorn mortars (in addition to the 100 pieces)				6	
Wall-pieces, for the attack of one front				40	

Gun Carriages.

For 24-pounder guns and 8-inch howitzers,	one-third spare	60
For 18-pounder and 12-pounder guns,	one-fourth spare	25
For 10-inch mortars and stone mortars,	one-third spare	38
For 8-inch mortars and stone mortars,	one-fourth spare	9

Other Carriages.

Transporting carriages for mortars.—1 for each 10-inch mortar and bed, for each stone mortar and bed, and for three 8-inch mortars and beds	38
Waggons, for transporting implements, &c., intrenching and miners' tools, laboratory tools and utensils, and other stores,—each loaded with about 2700 lbs., say	140
Trench carts (carrying balls, &c., on the march)	50
Battery waggons, 1 to 100 horses	28
Forges, fully equipped	8
Sling carts	5

Draught Horses.

For each 24-pounder and 18-pounder gun, and 8-inch howitzer with its carriage	8
„ 12-pounder gun with its carriage	6
„ spare gun carriage and forge	4
„ transporting carriage for mortars	8
„ park and battery waggon	6
„ trench cart	2
„ sling cart	2
Spare horses	$\frac{1}{10}$th
Total, say	1800

Projectiles and Ammunition.

For guns	Round shot	1000 to each 24-pounder	32,000
		1000 to each 18-pounder	10,000
		1200 to each 12-pounder	12,000
	Grape and canister, 50 rounds to each piece		2,600
	Spherical case, 100 rounds to each piece		5,200
For howitzers	Shells	800 to each 8-inch	10,400
	Canisters	50 do.	650
	Spherical case	100 do.	1,300
For mortars	600 shells to each 10-inch		8,400
	800 „ 8-inch		5,600
	600 „ Coehorn		3,600

Gunpowder, in barrels . . . . lbs. 500,000

Computing for each round shot, ¼th the weight of shot.

„ grape, canister, and spherical case, ⅙th the weight of shot.

„ round of howitzer ammunition,	5 lbs.	including charge of shells.
„ „ 10-inch mortar	7	
„ „ 8-inch do.	3	
„ „ Coehorn	½ lb.	
„ „ stone mortar	1	

Paper cartridge-bags, 400 to each piece 40,000

Cartridge-paper, bundles 200

Sabots, 200 to each gun and howitzer 13,000

Slow-match . . . . lbs. 4,500

Portfires 8,000

Priming tubes 80,000

Fuzes, ¼th more than the number of shells 40,000

Wooden bottoms and *baskets* for stone mortars, 800 to each . . 11,200

Percussion primers, for pieces furnished with locks, ¼ to spare.

Cartridges for wall-pieces, 500 rounds to each.

Cartridges, *powder*, *flints*, and *lead*, for small arms, according to the force of the army.

Most of the ammunition is transported by hired waggons.

Implements and Equipments. For each Gun.

3 Sponges—2 spare.	2 Thumbstalls.
2 Rammers—1 spare.	2 Priming wires—1 spare.
⅛ Worms.	1 Gunner's gimlet.
⅛ Ladles.	1 Tangent scale.
8 Handspikes—2 spare.	2 Mauls.
2 Lintstocks—1 spare.	1 Vent-cover.
1 Portfire stock.	1 Sponge bucket.
1 Pass box.	1 Broom.
1 Tube pouch.	1 Percussion lock.
1 Priming horn.	

For each Howitzer and Mortar.

Implements.	Howitzer.	Mortar.
Sponges and Rammers	3—2 spare	2—1 spare
Ladles	⅛	
Handspikes (2 shod, for mortar)	6—2 spare	6—2 spare

Implements.	Howitzer.	Mortar.
Lintstocks	2 — 1 spare	2 — 1 spare
Portfire stocks	1	1
Haversacks	1	1
Priming wires	2 — 1 spare	2 — 1 spare
Gunners' gimlets	1	1
Quadrants	1	1
Mauls	2	2
Fuze drifts	2 — 1 spare	* 2 — 1 spare
Mallets	2 — 1 spare	* 2 — 1 spare
Baskets	1	1
Tampeons	1	1
Sponge bucket	1	1
Broom	1	1
Percussion locks	1	–
Plummet	–	1
Pointing wires	–	* 2
Quoins	–	2
Shell-hooks	–	* 2 — 1 spare
Scrapers	–	1
Spatulas	–	* 1
Gunner's sleeves (pair)	–	1
Sand-bags, to wipe with	–	1

Scales and weights, funnel, set of powder measures of three sizes, shell plug-screw, and fuze extractor, to each battery magazine.

Implements marked * are not required for the stone mortar: the number of implements must be proportioned to the whole number of gun carriages, including the spare carriages.

Platforms.

For guns and howitzers,	one-tenth spare	72
For mortars,	one-eighth spare	40

Embrasure Shutters.

Half the number of guns and howitzers 33

Spare parts of carriages, &c. (*See 'Armament of Fortifications,'* p. 481.)

Spare parts of field carriages, as for field batteries.

Timber, and other Materials, for Repairs.

Proportion to the number of parts that enter into the construction of the carriages:

Axle bodies for siege carriages, $\frac{1}{50}$th—breech bolsters, $\frac{1}{20}$th—cheeks, $\frac{1}{30}$th—felloes, $\frac{1}{50}$th—spokes, $\frac{1}{30}$th—fork saddles, $\frac{1}{30}$th—poles, $\frac{1}{20}$th—hounds, $\frac{1}{20}$th—splinter-bars, $\frac{1}{20}$th—double trees, $\frac{1}{10}$th—square timber of various scantling—plank—wooden part of transporting carriages; of each $\frac{1}{20}$th.

Bar iron assorted, 80 lbs. to a piece, 8000 lbs.—steel, 5 lbs. to a piece, 500 lbs.—sheet iron, 50 sheets—iron wire, 400 lbs.—sheet tin, 100 sheets—nails and screws assorted.

Machines and Ropes.

Seven gyns, with tackle, complete—34 lever-jacks—14 jack-screws—20 wheel-barrows, $\frac{1}{5}$th for shells—7 hand-barrows—balances for weighing—10 spare gyn falls—75 double prolonges—75 single prolonges—drag-ropes, 200—trace-ropes, 300—men's harness, 50—small ropes, 200 lbs.—twine, of various sizes, 50 lbs.

Tools.

Sets of carriage-makers' and blacksmiths' tools—pioneers' tools, for the Artillery alone, 40 to a piece, say 4000; of which, 1600 spades, 270 shovels, 2000 mattocks, 130 picks—spare tool-handles, $\frac{1}{2}$. Axes, 5 to a piece, 500—bill-hooks, 10 to a piece, 1000—saws, various kinds, 200—10-ft. rods, 2-ft. rules, masons' levels, 100 of each—paviours' rammers, 200—mauls, 200—scythes, 8—miners' tools—baskets.

Laboratory Tools and Materials.

Two sets of laboratory tools:

Nitre, pulverized . .	1500 lbs.	Twine	50 lbs.
Sulphur, pulverized .	100 „	Tarred rope-yarn . .	200 „
Sulphur, roll . . .	100 „	Copper wire . . .	10 „
Pitch	150 „	Brass wire	10 „
Resin	150 „	Cotton yarn . . .	25 „
Bees' wax	50 „	Glue	10 „
Charcoal, pulverized .	200 „	Wrapping paper . .	10 reams.
Camphor	20 „	Tar	20 barrels.
Spirits turpentine .	10 gallons.	Mealed powder . .	300 lbs.
Sperm oil	5 „	Quick-match . . .	150 „
Linseed oil	2 „	Torches	100 „
Tow, tarred links, fire-stone, &c., &c.			

Instruments, Books, &c.

Two theodolites, or other instruments for measuring angles—2 levels and staves—2 compasses—4 surveying chains—diagonal scales—cases of mathematical instruments—spy-glasses—tables of artillery construction—tables of firing—logarithmic tables—drawing-paper.

Miscellaneous Supplies.

Smiths' coal, 20 tons—grease, in barrels—sand-bags, 500 to each piece of ordnance—chevaux-de-frize—scaling ladders—rampart grates, 50—tarpaulins, various sizes, 100—2 grind-stones—lanthorns, 100—sperm candles, 150 lbs.—lamp-lighters' torches—tinder-boxes, &c.—canvas.

ARMAMENT OF FORTIFICATIONS.

The kind and number of pieces of ordnance required for the armament of each of the fortifications are prescribed by the Secretary at War, according to their character and extent.

The carriages, ammunition, implements, equipments, and other supplies, for a fort on the war establishment, may be proportioned to the number of pieces on the following general principles, the application of which must, however, be regulated by the importance of the position, and by the peculiar circumstances of each case.

	For a Front of Attack.	For other Land Fronts, and for Sea-Coast Batteries.	
Carriages.			
Gun carriages. Casemate . .	One-sixth	One-eighth	More than the number of pieces.
Gun carriages. Barbette . .	One-third	One-sixth	More than the number of pieces.
Gun carriages. Siege . . .	One-third	One-sixth	More than the number of pieces.
Gun carriages. Field	One-third	—	More than the number of pieces.
Gun carriages. Mortar-beds .	One-fourth	One-fourth	More than the number of pieces.
Trench carts for advanced works	1 to 20 pieces	—	
Sling carts	1 to 25 ,,	1 to 25 pieces	
Tumbrils or hand carts . .	1 to 20 ,,	1 to 20 ,,	
Caissons	1 to each field-piece	—	
Forges, travelling (besides permanent forges) . .	1 to 30 pieces of all kinds	—	
Ammunition.			
For each gun and sea-coast howitzer . . .	800 rounds	250 rounds	$\frac{1}{10}$th grape and canister.
For each carronade . . .	100 ,,	100 ,,	$\frac{1}{2}$ grape and canister.
,, siege howitzer . .	600 ,,	200 ,,	$\frac{1}{20}$th grape and canister.
,, 10-inch mortar .	400 ,,	—	
,, mortar	—	200 ,,	
For 8-inch stone mortar and Coehorn . . .	600 ,,	—	

100 tbs. of stone to each charge of a stone mortar.

Rampart grenades, 300 to a front of attack.

For each piece of artillery of a battery for sorties, 400 rounds,

Gunpowder.—The quantity of cannon powder may be calculated on the following principles:

For each charge of a gun, ¼ of the weight of shot.

,,	,,	carronade, or 24-pounder howitzer	2 tbs.	
,,	,,	8-inch siege howitzer . .	4 ,,	
,,	,,	10-inch sea-coast do. . .	12 ,,	
,,	,,	8-inch do. do. . .	8 ,,	
,,	,,	10-inch mortar (light) . . .	7 ,,	Including the charge of the shell.
,,	,,	10-inch do. (heavy) . .	15 ,,	Including the charge of the shell.
,,	,,	8-inch do.	3 ,,	Including the charge of the shell.
,,	,,	13-inch do.	30 ,,	Including the charge of the shell.
,,	,,	stone mortar	1 ,,	
,,	,,	Coehorn	½ ,,	

To spare, for mining, fire-works, and waste, $\frac{1}{10}$th of the whole, including a proportion of mealed powder and its components, pulverized.

Fuzes, ¼ more than the number of shells.

Tubes, ½ more than the number of rounds.

Slow-match, 40 tbs. to a piece.

Cannon cartridge-paper, 1 sheet to a round.

Sabots, wooden bottoms for stone mortars.

Portfires, 1 to 15 rounds.

Percussion primers, ¼ more than the number of rounds, for pieces furnished with locks.

Small Arms.

Muskets	$\frac{1}{3}$	More than the number of troops of the several kinds, supposed to be fully armed and equipped.
Musketoons	$\frac{1}{3}$	
Pistols	$\frac{1}{3}$	
Artillery and Infantry swords .	$\frac{1}{25}$	
Cavalry sabres	$\frac{1}{5}$	

Wall-pieces, 50 to a front of attack, or a front exposed to escalade.

Ammunition.—Musket cartridges for each man 400
Musketoon, pistol, and rifle cartridges . . 100
Cartridges for each wall-piece 400

Spare powder for small arms, $\frac{1}{25}$th of the whole quantity required for the cartridges; cartridge-paper in proportion.

Flints, 1 to 10 rounds; percussion caps, $1\frac{1}{2}$ to a round, for arms with percussion locks.

Implements and Equipments for each Gun.

2 Rammers—1 spare.
2 Sponges—1 spare.
$\frac{1}{3}$ Worms.
$\frac{1}{3}$ Ladles.
2 Lintstocks—1 spare.
1 Portfire stock.
1 Pass box.
2 Budge barrels.
1 Tube pouch.
1 Priming horn.
2 Thumbstalls—1 spare.
2 Priming wires—1 spare.
1 Gunner's gimlet.
1 Hausse, or tangent scale.
1 Vent-cover, or lock-cover.
1 Percussion lock.
1 Water bucket.

For each Howitzer.

The same as for a gun, omitting *Pass box*, and adding—

1 Haversack.
2 Fuze setters.
2 Fuze mallets.
1 Fuze extractor to 6 pieces.
1 Quadrant.
1 Fuze saw.
1 Fuze gimlet.

For each Mortar.

2 Sponges and rammers.
6 Handspikes—4 shod.
2 Lintstocks.
1 Haversack.
1 Tube pouch.
2 Priming wires.
1 Gunner's gimlet.
1 Quadrant.
1 Plummet.
2 Pointing wires.
2 Quoins.
1 Tampeon.
2 Shell-hooks.
1 Scraper.
1 Spatula.
1 pair Gunner's sleeves.
1 Sand-bag.
2 Fuze setters, 2 Mallets, 2 Fuze saws — 1 spare.
$\frac{1}{2}$ Fuze extractors.
1 Basket.
1 Broom.
1 Tarpaulin.

The implements for *shells* are not required for the stone mortar.

For each Casemate Carriage (including the Spare Carriages).—2 traversing hand-spikes—2 truck handspikes—1 quoin, or elevating machine—4 chocks, 2 spare—1 broom.

For each Barbette Carriage.—4 manœuvring handspikes, 2 spare—1 tarpaulin or other cover—1 platform and 2 mauls; if the platform is not permanent.

For each Siege Carriage.—4 handspikes, 2 spare—2 mauls—1 platform.

Spare Parts for Repair of Carriages.

Proportion of the number of spare parts to that of similar parts which belong to the carriages:

Forks for traversing wheels of barbette carriages	$\frac{1}{20}$th
Pintles for siege carriage limbers	$\frac{1}{30}$th
Pintles for casemate carriages	$\frac{1}{20}$th
Linchpins	$\frac{1}{5}$th
Axletrees — for siege carriages	$\frac{1}{20}$th
Axletrees — for barbette carriages	$\frac{1}{40}$th
Axletrees — for casemate carriages	$\frac{1}{40}$th
Rollers for casemate carriages	$\frac{1}{40}$th
Bolster-plates for pintles not permanently fixed	$\frac{1}{40}$th
Wheels — for siege carriages	$\frac{1}{15}$th
Wheels — for barbette upper carriages (including rollers)	$\frac{1}{20}$th
Wheels — for casemate carriages	$\frac{1}{40}$th
Wheels — for barbette chassis	$\frac{1}{40}$th
Wheels — for casemate chassis	$\frac{1}{40}$th
Axle-washers, shoulder	$\frac{1}{20}$th
Axle-washers, linch	$\frac{1}{10}$th
Poles for siege carriage limbers, one-half ironed	$\frac{1}{4}$th
Elevating screws	$\frac{1}{8}$th
Double trees for siege carriages, one-half ironed	$\frac{1}{4}$th
Tongues (iron) for casemate carriages	$\frac{1}{10}$th
Nuts, assorted	$\frac{1}{10}$th

Timber, and other Materials, for Repairs.

Cheeks, stocks, naves, spokes, felloes, for siege carriages; of each $\frac{1}{20}$th—cheeks of mortar-beds, $\frac{1}{12}$th—handspikes, 4 to a piece—tool-handles, $\frac{1}{2}$—sets of timber for barbette carriages, $\frac{1}{20}$th—ditto casemate, $\frac{1}{40}$th—iron, assorted, 50 lbs. to each piece—nails and screws, assorted, 100 to each piece—steel, 1 lb. to each piece—sheet iron, 6 square feet to each piece—tin, 5 sheets to each piece—spare parts for small arms.

Machines, Ropes, &c.

Gyns, casemate and rampart, as may be required, according to the extent of the fort—jack-screws—capstans—lever-jacks—wheel-barrows, 1 to each piece—hand-barrow, for shells, 1 to each mortar—sling hand-barrow, and frame hand-barrow with legs, 1 to each gun and howitzer—platform balance, or scales and weights—gyn falls, $\frac{1}{5}$th spare—double prolonges, 2 to each gyn—drag-ropes—trace-ropes—small rope, 5 lbs. to a piece.

Tools.

Sets of carriage-makers', smiths', and armourers' tools—intrenching and miners' tools—saws—levels—paviours' rammers—10-ft. rods—2-ft. rules: the number of each kind to be regulated by the particular circumstances of each case.

Tools and Materials for Fire-works, &c.

Laboratory tools and materials, according to the extent and resources of the fort: see the proportion of those for a siege train. For each night of a siege, or for each night on which the guns will probably be served, have six tarred links to each piece, mounted on the ramparts of a front of attack, or of a sea-coast battery, and five fire-balls for a front of attack; six carcases for each large mortar on a front of attack.

Signal rockets, torches, fire-stone, &c., according to circumstances.

Instruments, Books, Stationery, &c.

According to the character and extent of the fort.—See 'Siege Train,' p. 476.

Miscellaneous Supplies.

Timber, plank, and boards—wood for sabots, fascines, gabions, &c.—pickets—coal, 5 tons to a forge—grease—grind-stones—rampart grates, 2 to each piece on the ramparts—sand-bags for the batteries of the front of attack—lanthorn, 1 to each piece—candles—oil—fire-engine and buckets.

Field-pieces, forming a part of the armament of a fortification, should be provided with their caissons, ammunition, &c., as for service in the field.

EQUIPMENT, MUSKET-BALL CARTRIDGE.

Musket-Ball Cartridge Equipment is important to every branch of the army, as regards an adequate supply and mode of conveyance. The several descriptions of musket-ball cartridge, and the mode of packing as adopted in the Laboratory at Woolwich, is explained in the article 'Ammunition.'

In order to regulate the supply and mode of conveyance, and describe the equipment, it is necessary to give the proportion required for an army taking the field. The Committee of Artillery Officers at Woolwich recommended that it should not be less than five times the quantity carried by the soldier, *i. e.* supposing the army to be sixty thousand, $60{,}000 \times 60 \times 5 = 18{,}000{,}000$ ball cartridges necessary for six months' active operations. This quantity could be only supplied in certain proportions, according to the immediate wants of the army, by establishing entrepôts, as the whole would require 1000 waggons and about 3600 horses for small-arm ammunition alone.

See Plate, 'Musket-ball cartridge carriage.'

The waggon constructed for this equipment* will carry 20,000 rounds, and is drawn by four horses: the wheels and axles are similar to the Ammunition Waggon, and it seems well adapted for the conveyance of musket-ball cartridges in any country where a field battery can move.

The supply of small-arm ammunition is usually afforded by organizing a certain number of waggons into equipments, in charge of detachments of Artillery; one equipment to each division of Infantry, a small proportion to Cavalry, and equipments in reserve in the following proportions:

---

* For the waggon of this equipment, as now adapted to the Service, see article 'Carriage.'

Table of Musket-Ball Cartridge Equipments.

Nature.	Cavalry Division for 80,000 rounds.	Infantry Division for 240,000 rounds.	Reserve for three Divisions carrying 400,000 rounds.	Remarks.
Waggons.				
Musket-ball	4	12	20	See Plate.
Forge	1	1	1	Ordinary forge waggon.
Store	1	2	3	Flanders waggon.
Total waggons . .	6	15	24	
Royal Artillery.				
Captain	–	1	1	
Lieutenants	1	2	3	
Surgeon	–	1	1	
Staff Serjeant . . .	–	1	1	
Serjeants	1	2	3	
Corporals	1	2	3	
Bombardiers . . .	2	4	6	
Buglers	1	2	2	
Gunners	18	36	54	
Drivers	12	30	48	
Farriers	–	1	1	
Shoeing Smiths . .	1	2	3	
Total	37	84	126	
Horses.				
Draught	24	60	96	
Saddle	3	6	9	
Baggage	1	4	5	
Total horses . .	28	70	110	

For an army of 60,000 men, there will be consequently

Two Cavalry equipments }
Six Infantry „ } 150 waggons,*
Two Reserve „ }

conveying 2,680,000 ball cartridges, or about $\frac{1}{7}$th of the proportion allotted to this army at the commencement of a campaign. As this supply is expended, the equipments will return to the entrepôt to be replenished.

The supply for a siege operation is afforded usually by taking the waggons of the country for this purpose.

The Artillery Department has the organization and charge of the musket-ball cartridge equipments to an army moving in the field, but the responsibility of the proportions to be supplied should be with the Adjutant-General's Department, which alone is acquainted with the expenditure and wants of the army: this has hitherto been thrown on the Artillery. It would appear to suffice, if these last kept the equipments efficient, and the requisite supply at the entrepôts, leaving the extent of that supply to be determined by the proper Department.

A musket-ball equipment, composed of two-wheeled carts, and drawn by two horses, has been used, and this equipment supplied the British army at Waterloo:

* Including forge and store waggons, as above detailed.

it was used in Ireland in 1845, and seems only adapted to limited operations, in advance.

The comparative utility of two and four-wheeled waggons has been well compared and discussed, and apparently finally settled in favour of the latter, by the Committee of Artillery Officers, whose opinions are too valuable, on this and all other equipments, to be passed over, and are given in the following extract:

"*Conveyance of Small-Arm Ammunition.*—The usual means of conveying small-arm ammunition in the British Service has hitherto been the musket-ball cartridge cart, holding 12,000 rounds, drawn by two horses: during the Waterloo campaign, however, only 10,000 rounds were carried in the cart, as that quantity was deemed a sufficient load, but this, in common slow movements even, was found too much for a pair of horses, far less could they be expected therefore to move at an accelerated rate when such was necessary.

"In the Peninsula, when it was an object to take forward as great a quantity of ammunition as possible, the carts carried the whole 12,000 rounds; but to insure its getting on there was a necessity for its being drawn by four horses, and the same would have been necessary in France, on account of the deepness of the cross roads, had the cart been loaded to its full extent.

"From the above, therefore, it appears that the present ball-cartridge cart, with the reduced load, is too much for a pair, and that it will contain too little ammunition for four horses.

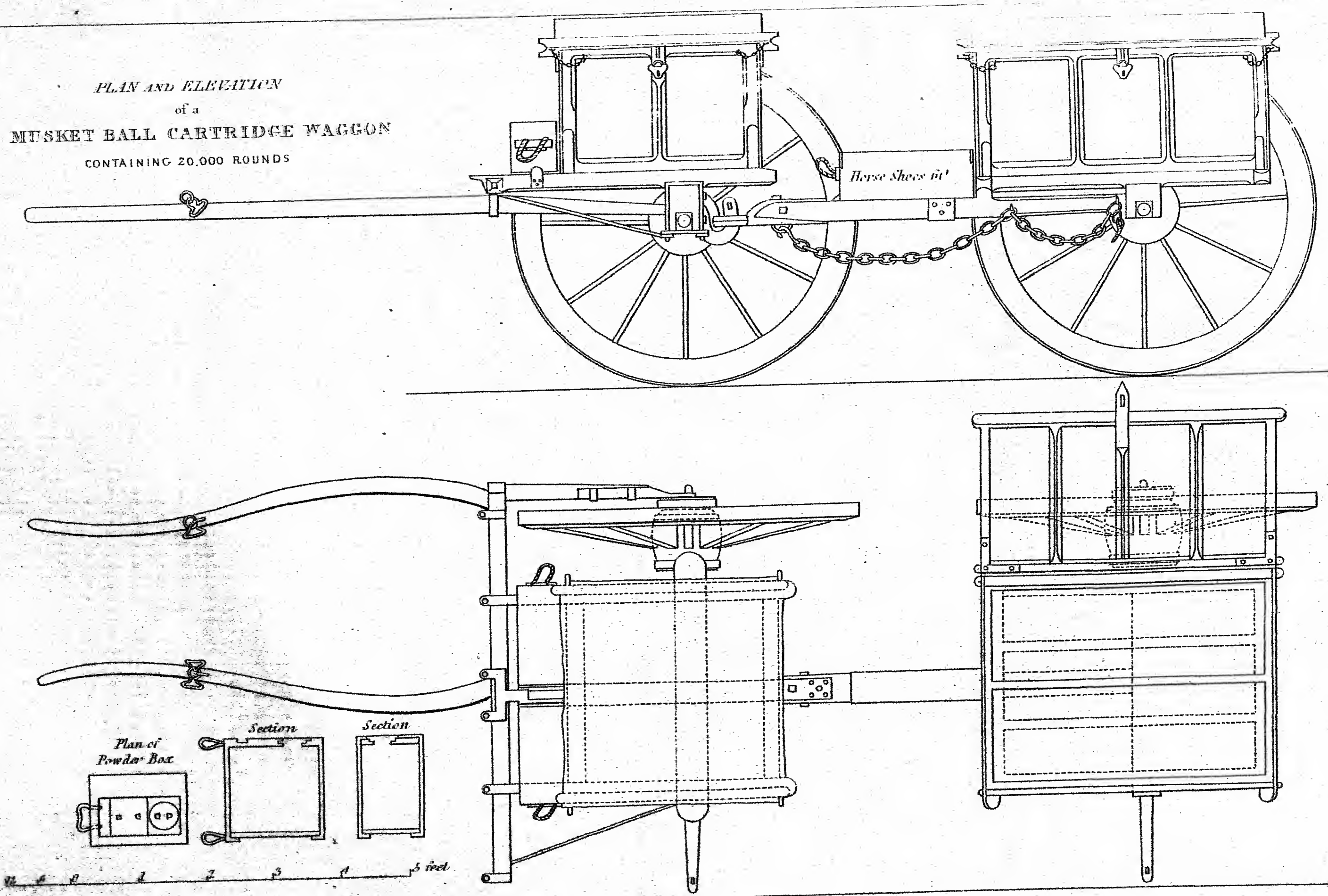
"To remedy this inconvenience, therefore, the Committee are of opinion that four-wheeled carriages for small-arm ammunition would be far preferable to carts, and would afford the power of a better application of physical force for their movements.

"The Committee have to shew, that although in their arrangement of field equipment the small-arm ammunition limber waggons are proposed for 24,000 rounds, to move with four horses, it is not without having adverted to the increased weight of the carriages thus loaded beyond the ammunition carriages, which would render a diminution of ammunition necessary in the event of a difficult country: at the same time it is deemed advisable that the waggon should be able to contain 20,000 rounds, in case the scene of operations admitted a facility of movement. There would, as circumstances varied, therefore, be the power of regulating the movement of small-arm ammunition as follows. In a good country, and the summer season, the waggon might move with 20,000 rounds, drawn by four horses; but in a difficult country, or a procrastinated campaign, the same load would require an additional pair of horses, and under any circumstances the service might be continued with four horses, by diminishing the load of the waggon to 16,000 rounds, which its construction would admit of without danger of injuring the ammunition.

"Another considerable advantage would be obtained also by the waggon being fitted for 20,000 rounds: it would afford the means of bringing forward the greatest possible quantity from the dépôts, and also moving forward a greater proportion to points of assembly preparatory to battles, or supply of advanced reserves, and which, in many instances, would admit of waggons being sent sooner to the rear for more ammunition.

"It may be argued in favour of two-wheeled carriages, that they would be more easy to conduct up great steeps, or extricate from difficulties; but reverting to the experience in Portugal, it may be considered as quite conclusive that a four-wheeled carriage, fairly horsed, like our ammunition limber waggon, can be conducted over every species of country where there is anything like a carriage-road; and, on the other hand, the carriages with four wheels would possess the following important advantages over those with two.

PLAN AND ELEVATION
of a
MUSKET BALL CARTRIDGE WAGGON
CONTAINING 20,000 ROUNDS



J.W. Lowry fc.

John Weale 59 High Holborn 1846.

"There would be less wear and tear of horses than with carts when all work in shafts, and consequently fewer spare horses would be required with waggon reserves.

"Carts would require to have all large, or what is termed wheel horses, whereas a mixed description of horse would be available for waggons to be distributed for wheel and leading, as is practised with batteries of artillery.

"Should it be required to detach ammunition with great expedition from a waggon reserve, towards any given point, it might be done by taking the leading horses from half the waggons, and advancing the other half rapidly with six horses, or by unlimbering and sending the limbers alone with four horses; and this is an advantage which carts would not admit of, for want of leading harness. The horses with waggons would be more ready to render mutual assistance to the carriages in difficulty than those with carts.

"In case of retreat and being pressed by an enemy, should the horses be hard-worked and the roads very bad, considerable casualties would naturally be the consequence, which would occasion many carts being lost or destroyed; for it would be impossible for a cart to proceed with one horse, though a waggon could do with three; that is to say, if a reserve of twelve waggons was reduced to thirty-six horses, it would still continue to move without diminution of carriage, whereas a reserve of twenty-four carts, under similar circumstances, would be obliged to abandon six carts; besides, in the time of march, should a horse drop in a waggon, it would be easily extricated, and the waggon move on, whilst, by the same thing occurring with a cart, if a spare horse was not at hand, the movement of the column would be either interrupted, or the cart thrown out of the road."

Note.—By a subsequent arrangement in the French Service, the musket-ball ammunition equipments are associated with the field batteries attached to divisions of Infantry.

ESCALADE.*

This article will comprehend three subjects.

1. The Means of effecting this operation, *i.e.* the Scaling Ladder.
2. The Arrangement before escalading works.
3. The Execution.

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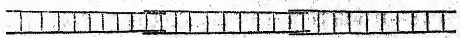
1. *There are two kinds of Scaling Ladder*, those in lengths, provided by Government with other Engineer stores, which have never yet been used,—and those of an impromptu kind, made for the occasion: the first description (used in the School of Instruction at Chatham) consists of ladders about 12 feet in length, which fit into one another, so that each joint will give an effective length of 10 feet: they are made tapering as explained in the annexed figures.

Fig. 1.



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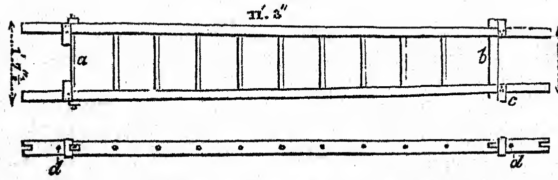
* Compiled by Major-General Lewis, C.B., R.E.

Fig. 2.



Sides $3\frac{3}{4}''$ deep by $2''$ thick.—Yellow pine.
a. Iron rung of $\frac{3}{4}''$ round iron.
b. Broad wooden rung: this and all except *a* are of oak.
c. Iron bands receiving the ends of the next ladder when fitted as in fig. 1.
d. Lashing-holes.
Weight about 50 lbs.

One length of Lieut.-General Pasley's ladder consists of two of the above joints and a half-joint or short ladder 7′ 6″ in length, with the same widths at top and bottom, as given in fig. 2.

The sides of the ladder to be of good yellow pine; all the rungs of oak except *a*, which is of $\frac{3}{4}''$ bolt iron. The clasps *b* to be of $2\frac{1}{2}'' \times \frac{3}{8}''$ flat iron.

The old regular pattern ladders, previous to the Peninsular War, were in lengths of 6 feet, very heavy, and when five or six were put together they broke down with their own weight: those used at Chatham are found to answer, and are extremely serviceable in practice, after having been brought to the most perfect state by various trials by Lieut.-General Pasley, at Chatham; they will likewise be found very convenient in the transport.

The second description of ladder in one length, such as those by which the escalade at Badajos and other places was effected, are made of light but strong wood; those in common use in building are of one spar sawn in two, wooden rungs, with iron rods under them, at about every 10 feet apart, and are easily made by any carpenter when suitable timber can be had: uffer poles are most esteemed in England. In the campaign in Affghanistan the bamboo was used, according to Lieut. Durand.* In experiments made at Chatham it was, however, found that these canes could not be bored without weakening them too much: the ladder, therefore, consisted of the two side pieces, and of rungs lashed across instead of passing through them.

These ladders in one length are extremely difficult of carriage, for which reason waggons are constructed on purpose; and in mountain and bad roads, owing to the great length of the ladder, they are unfit for transport. However, as they may be required again under similar circumstances, an account of them is here given.

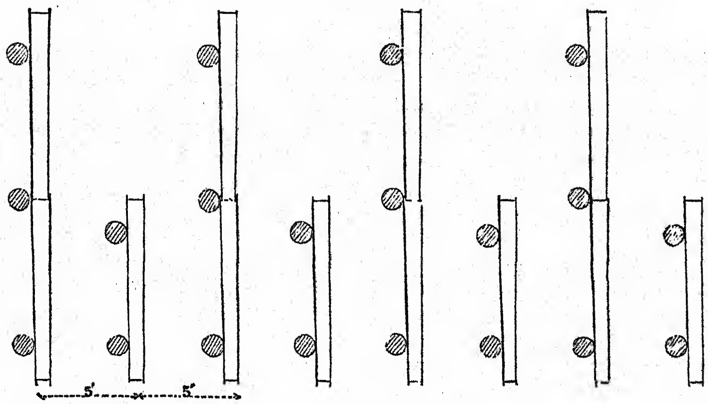
2. *The Arrangement for an Escalade.*—The arrangement for the transport of the ladder is a previous question, depending upon the description used, and is more appropriately considered under the head of 'Equipment.' It is presumed that they are carried to the spot by the Engineer Department, when the party intended for the escalade is to meet, unseen, and under cover if possible, 600 or 700 yards from work to be attacked. It is necessary, in order to be clear, to imagine the operation to be performed *either* by ladders in lengths or ladders entire: for the first, the arrangements taught at Chatham will be the data; and for the latter, those proposed by Lieut.-Colonel Jebb, in his 'Practical Treatise.'

Ladders in lengths.—It will be found convenient to fix them in double and single lengths alternately, as it is not possible to imagine any work to be escaladed less than

* Professional Papers, vols. iv. and vi.

10 feet in height: the double lengths are made fast with the lashing usually fixed to the ladders, so that in lowering them down to descend a counterscarp they will not separate; they will be, therefore, spread on the ground, as explained below, in alternate double and single ladders, in reference to the work to be escaladed, and in rows, as may be best suited to the place of deposit, with the broad end to the front, at 4 or 5 feet apart.

Fig. 3.



There will be required, therefore, two men to each length.

Ladders entire will be arranged at 4 or 5 feet apart, and will require six men to each ladder to carry them to the escalade: diagrams 4 to 9 will serve to explain the arrangement on the ground.

3. *The Arrangements for the Execution of an Escalade.*—The attack of works by escalade may be conceived the reverse of other assaults, being performed in open order instead of close when approaching the place (for the *general* operations of an assault, see the article 'Assault'): for the special operations the following suggestions are given, observing that it is immaterial whether there is a counterscarp or not, except that a greater number of ladders are required, and the operation will be described with *Ladders in lengths*, or with *Ladders entire*. Supposing in the former the number of 10-feet joints available to be 180, and in the latter (entire) 60; the assaulting party will be supposed to consist, in both cases, of 400 men, with a supporting party of the same strength; the height of the escarps having been ascertained pretty accurately:* observing that if there is a counterscarp, the ladders must be left there until the assault is over, which is sometimes omitted in instructions given, and which prevents the support following, and also renders the retreat impracticable. In all cases when there is a counterscarp, or that it is not very low, one-third of the ladders should remain there, and consequently an adequate provision thought of: hence it will be seen that the ladders in lengths are most convenient, as there would be no waste of material, which must be the case when they are entire, of 30 feet long, appearing an unnecessary height above the counterscarp, which would be the case were the ditch only 12 feet deep: leaving, therefore, a proportion of single ladders on a counterscarp, the party with the double ones will fix them on the escarp, raising them from below, if not of sufficient height, to fix one of more lengths, as may be;

* By the Engineer, preparatory to the escalade.

10 to 18 feet requiring 2 lengths,
18 to 28 „ „ 3 „
28 to 35 „ „ 4 „

but if possible the ladder should over-reach the height of the escarp 3 feet, to assist to get a foot on the rampart or wall.

The Escalade by Ladders in lengths.—These are now supposed to be arranged on the ground. The attacking party will be divided into—one-half as the covering party, to extend themselves with their bellies on the ground, on the crest of the glacis, to keep under the fire as much as possible,—the other half to be formed into sections of five, with arms and accoutrements, but the slings slacked. Reverting to fig. 3, each party of five will move between the alternate short and long lengths, consisting of 60 of two lengths, and 60 of one length, three men taking the long one, and two the other, on their right shoulders, having previously slung the musket (bayonet unfixed) over their left. On the word 'forward' the party will move onward, preceded by the Engineers, assisted by a detachment of Sappers, provided with axes and crow-bars, to the point of attack, between the files of the covering party. On reaching the *escarp* (the descent into the ditch being explained and provided for if there is a counterscarp) the threes with the double ladder will rear it by planting the butt end firmly on the ground; and conceiving, by way of example, the *escarp* or exterior revetment to be above 18 feet in height, the third ladder will be used by raising the double one and fixing the other below: this method will not be difficult, by extending the bottom of the first as far as possible from the wall, and then hoisting up all three: an escalade above 25 or 28 feet is rarely practicable except by surprise.* When the ladders are thus raised, the men will fix bayonets, carrying their muskets slung on their left arms, for the purpose of having a good hold of the ladder until near the top: those who precede should be provided with a sap-hook, to secure a good footing on the parapet, and the sap-hook is not a bad weapon if a personal encounter does occur: thus fixed, the advanced men of each ladder can give great assistance to those who follow.

The Escalade by Ladders entire.—This operation being preceded by the ladders being arranged similar to what is described in figs. 4 to 9,—the attacking party, as before, divided into two, one-half the covering party,—the other will be divided into sections of six, and move between the spaces of the sixty long or entire ladders, of about 30 feet in length;—when so posted, on the word 'forward,' with the arms slung, they will proceed to the attack: if there is a counterscarp, the whole of the ladders will be placed to descend, and when in the ditch two-thirds or forty will be carried forward butt on, according to Lieut.-Col. Jebb (in figs. 9 to 12), and raised against the escarp or exterior revetment, bayonets now fixed, and the escalade attempted, as before explained, the leading men of each ladder being provided with a sap-hook. It will be seen with these long ladders, that there is much difficulty in turning them over, particularly under fire, as they must be spread over very much of the breadth of the ditch.† But all escalades, to be successful, must be a sort of

* Vauban considered 36 feet French, or 38 feet 4 inches English, to be beyond escalade.

† "All the ladders used this night ‡ were the ordinary ladders of the English mechanics, and were made during the course of the siege. There were twelve supplied for this escalade, and the same number for General Leith's. They were called 30-feet ladders, but some of the longest measured 32 feet, and three or four not more than 28 feet.

"The experience of all the escalades in the Peninsula leads to the belief that such description of

‡ Storming of Badajos.

surprise, as against a garrison taken unawares, or otherwise occupied in a real or a false attack: they should be apparently desultory, and at various places, and moreover well supported by a reserve.

This operation is given by Lieut.-Col. Jebb in fuller detail, as follows:

"We have three companies in line, and we wish to carry the ladders forward, so that the front rank of the centre company shall be placed in a position to ascend the ladders first, and afterwards to stand at the head of a double column of subdivisions formed upon it,—we will say 20 yards in front of where the ladders are placed. The ladders are supposed to be laid out all ready on the ground, in front of the line, fig. 4. The cautions and words of command might be as follows.

"Form quarter distance column, in rear of the two centre subdivisions. See fig. 5.	According to regulation.
"By files extend from the centre and cover the ladders. "Outwards face—or Outwards close—Quick march.	The corresponding files of the 3 subdivisions would halt and cover the ladders in succession; the ladders and files having been previously numbered from centre to flanks.

Fig. 4.

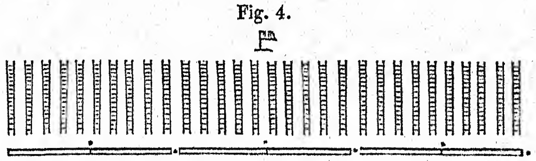
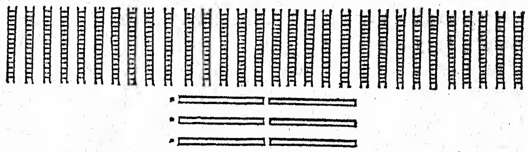
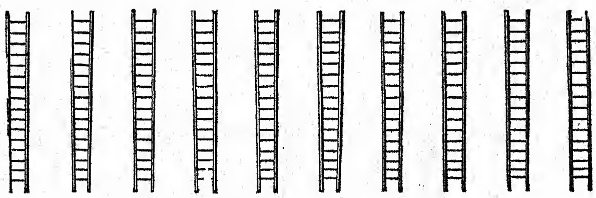


Fig. 5.





ladder is the best that can be used. The greatest difficulty experienced was to bring such unwieldy machines to the spot; but once there, they were raised readily enough, when not seriously opposed.

"Had the jointed scaling ladders, supplied as an Engineer store,* been sufficiently strong for the purposes of an escalade, they could not have been put together under the fire and missiles poured down on the assailants from the parapet on these occasions; and should any more perfect jointed ladders be substituted, it will always be found necessary to put them together before the garrison discover the party.

"These unwieldy ladders travelled on cars many marches with the army, but they are so readily

* The old pattern alluded to in the beginning of this article, not those of Lieut.-General Sir Chas. Pasley.

"The files would then be in the position shewn in fig. 6, and the rear rank men would merely have to step up into the same alignment as the front rank, instead of covering

Fig. 6.

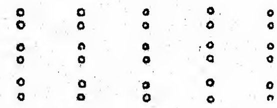
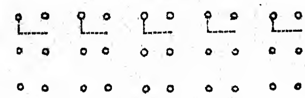
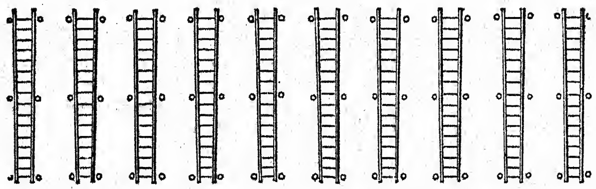


Fig. 7.



them (as shewn in fig. 7), and then being moved forward and filed between the ladders (fig. 8), they would be ready to advance with them in line; and by preserving

Fig. 8.



the order in which they then stood, or something like it, in ascending out of the ditch, they would be in their places for re-forming the double column again, in the situation required.

"It may be said, this is all very fine and regular, but how is such order to be preserved under a heavy and destructive fire? We answer,—the greater the probability of confusion, the greater is the necessity of taking every possible precaution to lessen the chance of it, and obviate its effects. It is not pretended that in the heat of action men could exactly keep their places,—the impetuosity and keenness of the many, and the *caution* of the few, would of itself prevent it,—but every man would be in his *right place*, when at the bottom of the ditch, for securing this formation; and they could not well be much out of it, in a compact column of three companies,—formed within so limited a distance to their front.

"This explanatory digression being ended, we must revert to where it commenced, and suppose the two lines of ladders are laid out, and that the men disposed on the above system are in readiness to take them up. The most convenient way of carrying ladders is on the shoulder (fig. 9); when therefore they were thus raised, the line

Fig. 9.

would be in readiness to advance, and in as close order as is practicable, which it may be observed, *en passant*, is a point to be attended to.

"The firing party would precede the ladders, and act according to circumstances,

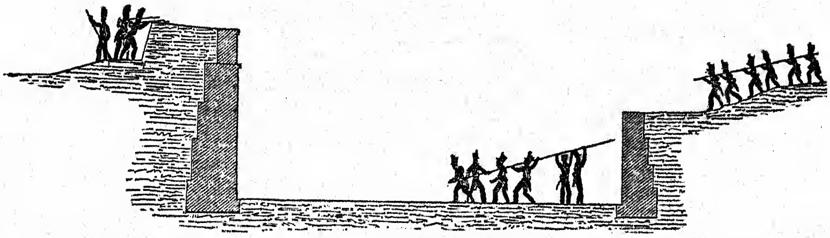
made when required, that it can seldom be worth the trouble of removing them from place to place. Their weight and strength were considered great advantages when once raised, as there were many hard struggles between those above to throw over, and those below to support the ladders, which would have broken less solid machines.

"It is believed that the honour of raising and forcing up the first ladder, on this occasion, attaches to Lieut.-Colonel Ridge, in command of the 5th regiment, who met his fate on the castle wall."—*Jones's 'Sieges,' Note* 21, *third edition.*

the object being to keep down the fire from the parapets or embrasures,—to prevent the enemy shewing himself, or making any attempt to throw the ladders back,—or in any way to arrogate to himself the right of assuming the offensive, outside the parapet: any such attempt should be regarded as a decided case of trespass, and should be dealt with accordingly.

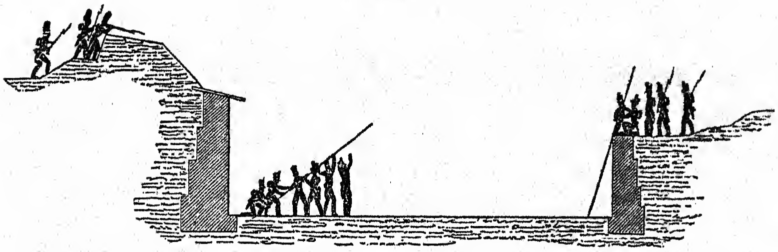
"The leading division, on arriving at the spot, would lower the ladders into the ditch (fig. 10), and the men would immediately descend, and when they were all

Fig. 10.



down would instantly shift them over to the opposite side, planting the foot of each ladder against the bottom of the scarp, and then turning the top over (fig. 11), the

Fig. 11.



foot being afterwards dragged away from the wall about one pace, to give it a little inclination; but the less it has the better, for the more upright, the stronger it will be; and it is also easier for the men to ascend than when there is much slope. The moment the first division of ladders were out of the way, the second would be lowered into the place from which they had been removed (fig. 11), and the men carrying them would in like manner descend; but those ladders would not be shifted across the ditch, but left where they were first lowered, and thus a complete communication would be established, by which the remainder of the storming party, and the support, could follow in close succession.

"With a still more scanty supply of ladders, or with greater means of resistance to be overcome,—in fact, where it would be very desirable to have the *whole* of the disposable ladders reared against the scarp for making the attack,—we must not be deterred from the attempt by apparent difficulties. Send them all on in one line if it *must* be so, carried by six men. Let another division of men descend before they are shifted across the ditch, and let the support jump down upon bags of hay, as they did at Badajos! Throwing a force into confusion, and letting men roll one over the other, will signify nothing in an escalade, in comparison of the evil effects which result from breaking the ranks of a close column on the eve of rushing forward to assault a breach; *that* is to be avoided by every possible means. But with

respect to an escalade, there will always be delay at the foot of the ladders; and if men get there at the time there is room for them to ascend, it is quite sufficient, and we need not be too particular as to their coming up in very regular order."

When an enterprise of this nature is contemplated, in most cases it is possible to practise the Sappers and men of the several regiments in escalading, and thus render the operation easy, or at least one without confusion; and as the material, *i. e.* either the long or short ladder, must have been provided, the instruction might be given with little trouble.

This article will be concluded by the following from Sir John Jones's 'Sieges,' rightly quoted by Lieut.-Col. Jebb as a brilliant example of daring and successful enterprise.

DESCRIPTION OF THE WORKS.

"The works at that place (Almaraz) had been constructed with great expense and labour, by the French, under the view of securing their communication across the Tagus, on both banks. On the right of the river they consisted of a redoubt for 400 men, on a very respectable profile, called Fort Ragusa, with a masonry tower in the interior 25 feet high, having two rows of loopholes for musketry.

"This work being situated so far from the bank of the river as to admit of the possibility of an attempt being made in the night to destroy the bridge in its rear, a flèche had been constructed on the river bank, which also served to flank Fort Ragusa.

"On the left bank, a well-flanked tête-de-pont, revetted with masonry on a good profile, secured the bridge; and as the ground rose immediately from the river to some heights which commanded the tête-de-pont at a short distance, a redoubt for 450 men had been constructed on their summit. This work, called Fort Napoleon, had a retrenchment across its rear, supported by a loopholed tower in its centre, 25 feet in height.

RECONNOISSANCE.

"18*th May*, 1812.—This morning, Lieut. Wright, of the Engineers, was sent out to gain all the information possible respecting the works, and the ground around them; whilst the Artillery Officers should renew their search for an opening to get their guns forward. The result of these examinations taking away all hope of forcing the Pass of Miravete, or of finding any other passage over the ridge practicable for artillery, the enterprise must have been abandoned, without some extraordinary decision on the part of its Commander. Happily that was not wanting, as will be seen below.

MOVEMENTS OF THE ESCALADE.

"At 9 P.M. the troops began to descend the Sierra, and the head of the column arrived in the vicinity of Fort Napoleon at daybreak: but from the difficulties of the road, although the distance from La Cueva did not exceed five or six miles, a considerable period elapsed before the rear closed up. Luckily, however, some intervening hills admitted of the head of the column being kept concealed from the garrison, at about 800 yards distant; and the troops remained undiscovered till completely formed. Soon after daylight, as had been concerted, under the expectation that it would be almost a simultaneous effort with the escalade of the forts, General Chowne made a false attack upon Miravete, and the 24-pounder howitzers commenced a distant fire of round shot and spherical case against the castle. This firing naturally attracted the attention of the garrison of Fort Napoleon, and put them on the alert. They mounted on the parapet, and watched with earnest curiosity the defensive efforts of their comrades in Miravete, but did not seem to have the slightest suspicion of the blow about to be struck against themselves.

"About 8 A.M. the rear of the descending column having closed up, the 50th regiment, and one wing of the 71st, moved forward to the assault of Fort Napoleon, regardless of a brisk fire that opened on them, as soon as discovered. They descended into the ditch of the outer work, at three points, and immediately reared the ladders; but from the great breadth of the berm the ladders could not be made to rest against the parapet. Each party, however, without being dismayed or confused, immediately ascended to the berm, and took footing upon it; then drew up the ladders, fixed them on the berm as a second operation, and almost simultaneously mounted the parapet, against a vigorous resistance.

"As soon as fifteen or twenty men were on the top of the parapet, the defenders of the exterior line gave way, and made for the communication to the retrenchment. This was by a narrow door-way, through a small building covered by the parapet of the outer line, from which a narrow bridge led to the inner defence, and seemed to render it secure; but the assailants followed the garrison so quickly, that they entered the door-way together, and a sharp but momentary contest took place, in which the French commandant was wounded and made prisoner. Overpowering numbers of the troops having now escaladed the fort, the garrison abandoned the retrenchment and the tower, and fled in the greatest confusion to the tête-de-pont, the assailants pursuing them so closely, that both parties pushed together into that work, when all resistance ceased.

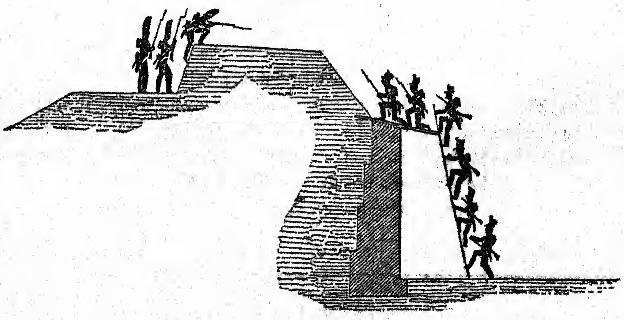
"The flying enemy crowded on the bridge to escape across the river, but those first over cut away three of the boats, in consequence of which a number of men and officers leaped into the river and were drowned, and the remainder, above 250, were made prisoners.

"The garrison of Fort Ragusa, seeing what had happened, opened a fire of artillery against Fort Napoleon, but Lieut. Love most promptly turned the guns of Napoleon against Ragusa, and after he had fired a few rounds, the French garrison evacuated the fort, made a hasty formation at the foot of the glacis, and then marched off towards Naval Moral.

"The reduction of these formidable works was thus effected by means of the musket and bayonet alone, and with the loss of only 2 officers and 31 men killed, and 13 officers and 131 men wounded."

"This is a history of what has been done with a scanty supply of ladders; when, therefore, we have 'impossible things' of this sort to accomplish, let us recollect what Hill did at Almaraz,—Picton and Kempt at the castle of Badajos,—Leith and Walker at the Bastion St. Vincente."

Fig. 12.



See Note 1.

EVOLUTIONS OF INFANTRY.*

"Troops are taught to execute every movement that can be required of them: the application of these movements can only be determined on the spot, according to the nature of the country, and the strength and dispositions of the enemy."—*Field Exercise and Evolutions of the Army*, Part IV. Sec. 8.

See 'Field Exercises,' Part IV. Sec. 3.

The ultimate object of tactical organization and movements may be defined to be *the formation of the line of battle by the shortest possible methods in any given direction and position.*

In investigating the methods by which this object is attained, it will be expedient, for the purpose of simplifying the inquiry, and of more clearly elucidating the principles involved in it, to consider the tactical constitution of infantry in the abstract; to view it merely as a means for effecting the movements of masses of men, without any reference to the application of these movements to the circumstances of war.

No reference will, therefore, be made to the objects which particular movements are calculated to effect, nor will any allusion be made to the combination of the action of infantry with that of cavalry and artillery.

The Tactical Constitution of Infantry involves three considerations—viz. its *Formation*, *Composition*, and *Evolutions*.

The points, then, to be considered are—

First. What is the primary formation, or order, most suitable for infantry.

Second. What is the composition best adapted for effecting the movement of masses developed according to this formation.

Third. What evolutions are necessary for effecting changes in the order, position, and direction of the primary formation.

FORMATIONS.

"Mais laquelle sera l'ordonnance primitive et habituelle? L'ordonnance de feu, ou celle de choc?

"C'est une question qui merite d'être discutée avec quelques détails, et examinée avec l'attention la plus réfléchie; j'ignore l'art d'être clair pour qui ne veut pas être attentif.

"La multiplicité de l'artillerie, la science du choix des postes, celle des retranchemens ont rendu aujourd'hui les actions de choc infiniment rares; donc celles de feu étant plus communes, c'est une raison de plus pour que l'ordonnance propre au feu soit l'ordonnance primitive et habituelle."—*Guibert, Essai Général de Tactique. Tactique de l'Infanterie*, chap. I.

When a mass of men encounters an opposing force, it should be so arrayed that the efforts of every individual may be available for the destruction of the enemy, and that these efforts may be as much concentrated as possible.

It follows, therefore, that the order in which a body of troops should be formed ought to be determined by a consideration of the nature of the arms and modes of offence used in the existing system of warfare.

In ancient times battles were chiefly decided by the personal encounter of the combatants, and the power of infantry consisted in the vigour and unity of its shock.

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* By Captain Robertson, 8th Regiment.

Masses of pikemen, like the Macedonian phalanx, or single ranks of swordsmen, like the Roman cohorts, were formations well adapted for this mode of fighting.

At the present day the collision of large bodies of infantry is a spectacle which is seldom witnessed; positions are assailed and defended by showers of bullets; the vigour of an attack is measured by the force, number, and precision of the projectiles directed on the point assailed; and battles are won less by the exertion of superior strength than by the relative position of the antagonists and the pertinacity of more obstinate endurance.

The power of modern infantry, therefore, principally consists in the quantity and precision of its fire; and its formation ought to be so determined as to render the fire of the line as effective as possible.

To attain this object, the order of formation should fulfil the following conditions:

First. The effect of the fire of a body of troops should always be in proportion, or nearly in proportion, to its force.

Second. Its fire should be as much concentrated as is consistent with the above condition.

Hence it follows that, provided the fire of every individual composing it can be rendered effective, the closer and deeper a body of infantry is formed, the more formidable it will be.

The nature of modern warfare seems to require that the formation of infantry should be in accordance with these principles, and that by reference to them should be determined the number of ranks of which the line of battle should consist.

The practice of European armies, however, differs on this fundamental tactical point, and the opinions of tacticians are divided as to whether infantry should be formed in double or treble ranks.

In order to come to a just conclusion respecting the relative merits of these two formations, it would be necessary to ascertain satisfactorily if the fire of a line of three ranks is more effective than the fire of a line of two ranks, nearly in the proportion of the strength of the lines, that is, nearly in the proportion of three to two, the extent of front of both lines being the same.

This could be easily ascertained, provided the results of target practice might be considered as a true indication of what takes place in the field; and, however much such results might differ from those which would be exhibited were it possible to obtain an accurate state of the casualties resulting from the actual encounter of a double and a treble line, yet the results of target practice, if collected from careful, extensive, and judicious experiments, could not fail to be valuable, as representing what takes place under certain normal conditions, and therefore constituting a basis of comparisons which might be afterwards modified by statistical observations of the casualties of battles.

It may, indeed, be alleged that the question has been decided by the experience of late wars. But though these wars present numerous instances of British troops formed two-deep successfully contending with the three-deep formations of continental armies, it would be scarcely logical to draw from these instances any abstract conclusion respecting the merits of the two formations.

The successes and achievements of a double line of British soldiers are very far from proving that a treble line of the same soldiers would not be even more formidable to an enemy.*

* Whether this be true or not, the facility of occupying an extent of ground must not be forgotten; and on the decision as to whether ranks are to be three-deep or not will depend whether the line is to be reduced to two-thirds of its present length or not. See, however, Note 2.—*Ed.*

The following passages are extracted from the translation of the Duke of Ragusa's work, which appeared in the 'United Service Journal' for February, 1845.

They contain the decidedly expressed opinion of a great and experienced soldier in favour of the two-deep formation.

"Nothing can be said in favour of a third rank, for, without entering into a detail of volleys, persons of experience know that if one can at a review fire a volley in three ranks, it is impossible in war.

"It is ascertained to be impracticable to hand over the firelock to the third rank, as the French order prescribes.

"This method, being merely theoretical, is by no means applicable to the face of an enemy.

"In fact, the third rank, of its own accord, in a few moments forms into the other two; the most advantageous formation is, therefore, instinctively adopted; but as the change is made contrary to order, there results from it a kind of disorganization.

See Note 2.

"It is better, therefore, to adopt the two-deep formation, and to render it permanent."

The fact on which Marmont rests his opinion is, perhaps, of itself scarcely sufficient to justify an absolute conclusion, since it by no means necessarily follows that the most natural formation should be the most advantageous.

Marmont's testimony, however, most clearly proves that if not altogether impracticable, it is at least extremely difficult to bring the fire of a treble line of infantry to bear on an enemy, and that the treble formation, if suitable at all, is only so for veteran and highly disciplined troops.*

COMPOSITION.

"Comment faire marcher une ligne mince et flottante?

"Le voici; c'est en divisant une troupe nombreuse en plusieurs parties qu'on peut parvenir à la mouvoir avec facilité. Ce sont ces divisions, connues de tout temps dans la tactique qu'on appelle 'régiment,' 'bataillon,' 'escadron,' 'compagnie,' 'division,' &c. Cherchons à établir quelles doivent être leurs proportions."—*Guibert, Essai Général de Tactique. Tactique de l'Infanterie*, chap. I.

To effect any change in the formation or position of an extensive line, it is necessary to divide it into sections of a manageable size, and by a combination of the movements of these sections, to accomplish the required change.

The object of this composition is to secure facility and regularity of movement; but it must be remembered that the splitting of a mass into parts has a tendency to impair the vigour and unity of its action. Care ought, therefore, to be taken not to carry the process to a greater extent than is absolutely necessary to provide for facility of movement.

The Battalion. The most important of tactical divisions is the Battalion; it corresponds to the cohort of the ancients, and may be considered as the unit of the modern tactical system.

The characteristic feature of this division, on which its utility depends, is its

* At the battle of Maida, the British Infantry were without their flank Companies, which were formed into flank Battalions; and the eight Companies of what may be termed the Line Battalions had a small portion of each Company told off into skirmishers, who retreated in the intervals made by the Officers stepping aside. These skirmishers, or Light Infantry, formed a third rank, and filled up the vacancies as they occurred.

The Infantry Battalions of the King's German Legion had no flank Companies, and were composed of eight Companies to each Battalion.

In the formation of Battalions one important point has been lost sight of in this discussion, that

capacity of receiving a simultaneous impulse from the word of command of its chief. Hence the strength of the human voice is the circumstance which ought to determine the limits of the strength of the Battalion.

The strength of the Battalion as it is actually constituted in our own and other European armies varies from 600 to 1000 men. The extent of its front in the two-deep formation is, therefore, from 233 to 388 yards.

An Officer placed near the centre of a line 600 strong can, under ordinary circumstances, without any great effort, make himself distinctly heard by every individual composing it; but the compass of the human voice is scarcely sufficient to direct the movements of a line of 1000 men formed two-deep. In armies, therefore, where this formation is adopted, the *effective* strength of a Battalion should never be allowed to exceed 700 or 800 men.*

See Note 3.

The Company.

The Company, or primary fraction of the Battalion, ranks next to it in importance. The principal things to be considered respecting it are—

I. Its strength.

II. The aliquot relation it ought to bear to its whole.

I. Strength of the Company.

The Company, which may be regarded as the ultimate and indivisible element of tactical organization, ought to possess the utmost flexibility and facility of movement, and ought at all times and under all circumstances to be able to change its position and direction without the order of its primary formation being altered or disturbed.

The principle mentioned as determining the constitution of the tactical unit, viz. *the capacity of receiving a direct impulse from the voice of its chief*, only involves one of the conditions on which depend the facility and flexibility of the movements of a military body.

To insure regularity and precision of movement, a simultaneous impulse must not only be given to the individuals composing the moving body, but the motion of each must be regulated so as to bear a certain definite relation to the general movement.

These individual rates of motion may be either equal or unequal, according to the nature of the movement; *e.g.* they are equal in line marching on level ground, and unequal in wheels.

See Note 4.

But whether equal or unequal, the difficulty of regulating them with precision is very great.

1st. On account of the diversity of the paces of the individuals themselves.

2nd. On account of the irregularity of the surface of the ground on which they must move; which irregularity produces a diversity in their facilities of motion.

It is therefore evident that, from the operation of these causes, as the numbers composing the moving body increase, the difficulty of preserving order in its movements increases in a compound ratio.

See Note 5.

This difficulty, on tolerably even ground, may, to a great extent, be overcome by careful drilling; and there is no doubt that it is possible, under favourable circumstances, to manœuvre lines of very considerable extent without breaking them into parts.

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there is this additional disadvantage of three-deep,—the greater liability to casualties, and that a gun-shot will disable three men as easily as two.—*Editors.*

* The Battalion is unquestionably the Unit of Infantry, the Company the Fraction, and Brigade, Division, and Corps, the Multiple: this distinction in the composition of Armies is essential.

The strength of a Battalion must be regulated by the early probable casualties, of sick, and detachments; and if each Company enters a campaign 100 strong, it is probable that on no occasion will Battalion exceed 800 in action. See, however, Note 2.—*Editors.*

But taking into account the variety of ground in which troops must be capable of acting, and the difficulty of training men to a perfectly uniform rate of march, 50 files may be assumed as the maximum development which ought to be given to the element (or the fraction) — a Company, and between 30 and 40 files a convenient strength for manœuvring.

Excepting on ground which is absolutely rugged, a line consisting of between 30 and 40 files ought to be able to march and to wheel without the order of its formation being materially deranged.

II. Number of Companies which ought to constitute the Battalion.

Symmetrical manœuvres, such as the formation of squares and of double columns, require that the Battalions should be always composed of an even number of Companies.

Whether it be composed of 4, 6, 8, or 10 Companies is a matter of no tactical importance; but when columns of the same strength manœuvre together in masses, it is desirable that the number of the divisions and the intervals between them should be so proportioned to the extent of their front that, in close column, the front should not exceed the depth of the column.—See 'Field Exercises,' Part IV. Sec. 4.

See Note 6.

Subdivisions of the Company.

Subdivisions, sections, and sections of threes, are useful in defiling, and in some manœuvres; but these minute subdivisions are so liable to derangement from casualties that they ought to be considered, not as primary and fundamental parts of military organization, but merely as secondary and occasional aids to facilitate the working of the system.

In defiling, it may be suggested, that it would be convenient to tell off the troops in sections corresponding to the breadth of the defile, without reference to the manner in which the Company is usually subdivided.

Divisions and Brigades.

It now remains to examine the constitution of masses consisting of the aggregation of several tactical units.

If it were attempted to determine the composition of a Division consisting of several Battalions according to a definite principle, then, by an extension of that used to determine the strength of the Battalion, the idea would naturally suggest itself of composing the Division of as many Battalions as the Battalion contains Companies.

The front of such a mass of Battalions formed in contiguous columns would not much exceed the front of a single Battalion deployed, and such a mass might, therefore, be manœuvred by the direct command of its chief with nearly the same facility as a single Battalion.

The constitution of the Divisions composing the Peninsular army was similar to that here suggested, but it is not meant to be asserted that this constitution was determined by the analogy pointed out as subsisting between it and the constitution of the Battalion.

In the Duke of Wellington's army, the Division of ten Battalions was further organized in three Brigades, for the adoption of which subdivision the writer of this article is not aware that any purely tactical reason can be given.

Military organization, besides its tactical uses, is necessary to carry into effect administrative and logistic arrangements.

With reference to these arrangements, the classification of Battalions in divisions and brigades is of the greatest importance; but it is certainly erroneous to suppose that it is consistent with the usual practice of armies to adhere strictly to systematic analogies in the tactical arrangement and distribution of an army in the field, or to imagine that such precision, if attempted, would be suitable to the circumstances of war.

See Note 7.

When manœuvring in presence of an enemy, a General estimates his force accord-

ing to the number of Battalions of which it is composed; and, considering these Battalions as independent bodies, he combines them without regard to the preservation of the unity of brigades or divisions, in reserves and columns of attack, each consisting of a number of Battalions proportioned to the object it is intended to fulfil, and each liable to vary in its strength when circumstances require fresh combinations.

It is these Columns and Reserves, and not Divisions and Brigades, which constitute the real tactical divisions of an army.

A Reserve, consisting of a mass of several brigades, will frequently be estimated and employed by a General as a single quantity, while a detached Battalion, occupying an essential point, may sometimes enter into his calculations as a separate and important element.

EVOLUTIONS.*

"Il faut des évolutions, car sans évolution, une troupe ne serait qu'une masse sans mouvement, réduite à l'ordre primitif dans lequel on l'aurait placée, et incapable d'agir au premier changement de terrein ou des circonstances. Les évolutions sont donc les mouvemens par lesquels une troupe doit, relativement aux circonstances et au terrein, changer d'ordre et de situation.

"Elles doivent être simples, faciles, en petit nombre et relatives à la guerre."—*Guibert, Essai Général de Tactique. Tactique d'Infanterie*, chap. v.

If we examine the Evolutions prescribed in existing systems of Tactics, we shall find that it is not in all cases the simplest and shortest methods which have been chosen for effecting changes in the position and direction of the line of battle. In changes of front to the rear, for instance, a battalion does not simply face to the right about, but the change is effected by a tedious series of counter-marches.

In this and in other instances the most direct method of performing an evolution is abandoned, or greatly modified, for the purpose of preserving the relative position of the parts of the line in the order of their original formation.

Subjecting the formation of the line to the condition of the preservation of the parts of which it is composed in a certain fixed order has the disadvantage of complicating the theory of military movements, and occasionally of producing perplexity in their execution.

It would greatly increase the flexibility of military bodies if the utmost freedom of inversion were permitted; if the system of arbitrarily determining the front and rear, and the right and left flanks of a division, and of framing a system of manœuvres with reference to the preservation of these distinctions, were abandoned; and if, instead of permitting inversions as an exception, as is now the case, it were established as a general principle that the line should invariably be formed by the simplest and shortest possible process, without the least regard to which rank of a division might be placed in front, or which of its flanks on the right or left of the line.

As, however, this principle is not recognized otherwise than as an exception by any existing system of tactics, it is sufficient to suggest the possibility of its extended

* Lloyd observes that all Infantry Evolutions are but means of forming Line, or forming Column: to these may be added, in the British Service, the four-deep square; so that all *drill* may be carried on as a series of changes on the different elements,—Line, Column, Square,—Line, Square, Column,—Column, Line, Square, &c., &c., &c., whether referring to the Company, Battalion, or Brigade.—*Editors.*

application, without minutely discussing the probable effects of its adoption, or indicating the details by which it might be carried into execution.

In examining the different changes of position and direction of which the line is susceptible, those methods only of effecting these changes will therefore be noticed which are in accordance with the systems of tactics at present established in European armies, *i. e.* those systems based on the principle, *that in all formations the relative position of the portions of the line shall be preserved unchanged.*

EVOLUTIONS OF THE BATTALION.

The Evolutions of the Battalion are executed by means of combinations of the facings, marchings, and wheelings of the companies of which it is composed.

The Facings require no explanation.

Some observations on marching will be found under that head.

Wheeling. Concerning Wheeling, it may be remarked that, in changing the direction of a column on the march by the successive wheel of its divisions, there necessarily results a loss of time proportioned to the strength of the division, and to the angle of the wheel; and that in certain manœuvres, such as retiring in double column from both flanks in rear of the centre, the nature of the wheel also involves a loss of distance. To avoid these two inconveniences of loss of time and loss of distance, the French in some cases employ the following method of changing the direction of a column on the march.

Supposing right in front, and the change to be to the left, as each division approaches the point where the change of direction is to take place it receives the caution, '*tournez à gauche*,' and on reaching the point, the word '*marche:*' at this word the *guide* (or pivot-man) immediately turns into the new direction, and continues his march, without altering either the length or cadence of his step; the other men, lengthening their pace, and bringing their shoulders forward, gradually align themselves on the guide, each man, as he gains the alignment, resuming his former step and rate of march, and conforming to the pace of the guide.

The object of Battalion manœuvres is either to effect a change in the primary formation of the battalion, or a change in the position of that formation.

CHANGES OF FORMATION.

Changes of formation are designed,

1st. To facilitate the movements and changes of position of the line. Hence changes of position generally involve preliminary changes of formation, or—

2ndly. Changes of formation are designed to substitute one order of battle for another, when circumstances require the change.

Columns and echellons are, in the British Service, formations made use of to effect changes of position.

Squares and the open formations of skirmishers are instances of changes in the order of battle.

Columns. Columns may be formed either to the front or to a flank, by methods to which, on account of their simplicity, it is not necessary to advert.

The strength of the divisions of a column and the distance between them are regulated by the purpose for which it has been formed.

In Route-Marching and Defiling the front of the division is determined by the breadth of the road or defile; and, as a general rule, full distance ought to be preserved between the divisions, since, if the intervals were less, the ranks could not be opened and the files loosened without the danger of the divisions becoming mixed,

while, if the intervals were greater, the compactness of the column would be destroyed, and its capacity for manœuvring impaired.

In Columns of Manœuvre, that is, in those columns which are formed with an immediate view to the re-formation of the line, it is generally advantageous that the front of divisions should consist of as many files as can move in line without disorder. The divisions of a column should therefore generally consist of companies, or, where the front of the company is small, columns of grand divisions may frequently be adopted with advantage.

The proper distance between the divisions depends on the immediate object in view. If a formation is to be made to a flank, the divisions ought to be formed at full distance; but if to the front or rear, the divisions should be closed until the intervals are only sufficient to preserve the separation between them, and line should be formed by deployment.

The interval of one pace, which is left between the divisions of a British column when closed, will not admit of the free passage of the Officers, and is, perhaps, scarcely sufficient to prevent confusion. In the French Service, six paces is the prescribed interval between the divisions of a column, *serrée en masse*, which, on the other hand, appears too great for a minimum.

In forming to a flank, single columns are the most convenient; but in deployments and other front formations, double columns on the centre ought always, when practicable, to be adopted.

Echellons.

The method used in the British Service for determining the angle of the wheel of oblique echellons by reckoning 8 paces on the circumference of the arc wheeled by the eighth file for the quarter circle, four for $\frac{1}{8}$, two for $\frac{1}{16}$, and so on, depends on the circumstance of $\frac{21}{30}$, the ratio between the space occupied by the front of a file and the length of a pace being not very different from the ratio of the radius to the quadrant: since, therefore, circumferences are to one another as their radii, it is evident that whatever may be the strength of the division, the number of paces taken by the outer man in wheeling will always be nearly equal to the number of its files.

In the practical application of this rule much inaccuracy is produced by the serjeants not taking the number of paces ordered in the true direction of the arc: the inaccuracy proceeding from this cause is probably quite as great as if the angle of the wheel were determined by the eye, as is the case in the French Service.

Squares.

The British method of forming squares from columns of companies is attended with the inconvenience of separating companies into fractions. By forming square from column of grand divisions, this inconvenience is avoided in the French Service, and the parts of a company are not separated by this manœuvre.

CHANGES OF POSITION.

There are four methods by which a Battalion may be fixed in a given alignment.

First. By establishing the flanks of the divisions in the alignment, and wheeling them backwards or forwards into line; or, if moving to a flank, by the divisions forming on their leading files.

This method is of extensive application in effecting changes of front, both of the battalion and of larger bodies.

The divisions may either be formed in column perpendicular to the alignment, or in echellon, oblique to it. It is not even necessary that they should be parallel to one another. The accuracy of the formation entirely depends on the position of the pivot flanks of the divisions, and is not at all affected by the direction of their fronts.

Second. By directing the march of a column along the rear of an alignment, and prolonging the line by the successive wheel of the divisions to the reverse flank.

In prolonging a line by this method, each division should wheel up in double time, otherwise the succeeding division will overtake it before the wheel is completed, and the march of the column will be impeded.

Third. By wheeling a close or quarter distance column, so that its front may be parallel to the alignment, and deploying on any named division.

Respecting this method, Guibert, who wrote soon after its invention, thus expresses himself:

"This is the most clever (*savante*) of evolutions, the most susceptible of combination, and yet, both in its conception and execution, the most simple of all. We owe it to the King of Prussia; from his armies it has spread to those of all other European nations."

For the changes of position of extensive lines it is seldom that any other method but that of columns and deployments will be found suitable. (See 'Field Exercises,' Part IV. Sec. 7.)

Fourth. By forming on any named division of a direct echellon, or by establishing a division in the alignment and forming upon it by wheeling the others into oblique echellon, so regulating the angle of the wheel that the lines joining their inward flanks and the points where they are to enter the alignment shall be perpendicular to their fronts.

A direct echellon is the disposition which is generally given to an army when about to engage, and considerable advantages have frequently been obtained by the skilful use and management of this disposition. (See 'Field Exercises,' Part IV. Sec. 6.)

In good ground, oblique echellons may be advantageously used for changing the position of a line of small extent; but when the ground is rugged, or the distance which the divisions have to traverse is great, it is difficult to preserve the true direction of the march of the divisions.

Oblique echellons are, therefore, ill adapted for the manœuvres of extensive lines.

Annexed is a synopsis of the principal manœuvres contained in Part III. of the 'Field Exercises of the Army.'

The various changes of formation, direction, and position, of which the line is susceptible, have been classified, and the different methods pointed out which have been established by regulation for effecting each of these changes.

In Foreign Services similar methods are made use of for effecting like objects.

SYNOPSIS OF THE MOVEMENTS OF A BATTALION.

See 'Field Exercises,' Part III.

I. CHANGES OF FORMATION.

A. Columns.
1st. To the front, by the flank march of divisions.—Sec. 30.
2nd. To a flank, by the wheel of divisions.
3rd. Double, on the centre subdivisions.

B. Echellons.
1st. Direct, by the successive march of divisions.—Sec. 44.
2nd. Oblique, by the wheel of divisions.—Sec. 37.

C. Squares.
1st. From line, on the two centre subdivisions.—Sec. 21.
2nd. From column, on any named division.—Sec. 29.*

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* Sect. 22. The Oblong two-deep Square against Infantry only, for the protection of baggage, &c., has been omitted, as apparently of a character subordinate to that of 'General Manœuvre.'—*Ed.*

II. CHANGES IN THE POSITION OF THE LINE, THE DIRECTION OF THE ALIGNMENT REMAINING UNCHANGED.

A. When the change is directly to the front or rear, the alignments being parallel.

1st. By advancing or retiring in line.—Sec. 14.

Plate I. fig. 1. 2nd. By advancing or retiring in direct echellon, and re-forming on any named division.—Sec. 44.

Fig. 2. 3rd. By the flank march of divisions; the divisions afterwards fronting and wheeling into line, or forming on their leading files.—Sec. 16.

Fig. 3. 4th. Advancing in open column from a flank, and re-forming line by echellon on the front division.—Secs. 18, 43.

Fig. 4. 5th. Advancing in double column from the centre, and re-forming as above.—Sec. 18.

6th. By retiring from either flank, or from both flanks, in rear of the centre, and re-forming line as above.—Sec. 19.

B. When the alignments are parallel, but the one outflanks the other. Fig. 5.

1st. By throwing the divisions into echellon, advancing, and wheeling back into line.—Sec. 37.

Fig. 6. 2nd. By forming close or quarter-distance column on any named division, conducting the column to the place required, and deploying.—Secs. 30 and 36.

C. In prolongation to a flank.

1st. By breaking into column to either flank, advancing, and again wheeling into line.

Figs. 7 and 8. 2nd. By divisions successively passing from either flank along the rear, and again wheeling up in succession.—Sec. 20.

III. CHANGES OF DIRECTION WHERE THERE IS A POINT COMMON TO THE OLD AND NEW ALIGNMENTS.

A. To a flank. Fig. 9. 1st. By the formation of open columns, and wheeling into line.—Sec. 24.

Fig. 10. 2nd. Wheeling a division into the new direction, throwing the others into echellon, and forming upon it.—Secs. 40, 41, 42.

B. To the rear. By the counter-march on the two centre divisions.—Sec. 23.

IV. CHANGES OF THE POSITION AND DIRECTION OF THE LINE.

A. To a flank. Fig. 11. 1st. Breaking into open column, and re-forming line either to the front or oblique to the front by echellon.—Sec. 43.

Fig. 12. 2nd. Breaking into open column, advancing, and entering the new alignment by the flank march of companies.—Sec. 25.

3rd. Marching in close or quarter-distance column to the point of formation, wheeling the column into the new direction, and deploying.—Secs. 33–36.

Fig. 13. 4th. Advancing or retiring in double column, and forming to a flank.—Sec. 18.

Plate II. fig. 1. 5th. Advancing in direct echellon, changing the front of the echellon, and forming on any named division.—Sec. 44.

Fig. 2. 6th. Advancing in direct echellon, determining the direction of an oblique alignment by means of a point placed in advance of the leading flank of the echellon, establishing the rear divisions in that alignment, and wheeling back into line.—Sec. 44.

B. To the rear. Fig. 3. Breaking into open column, and forming to the reverse flank by the successive wheel of divisions.—Sec. 26.

C. Do. from column.

1st. By the divisions counter-marching and deploying.

2nd. By counter-marching the column, by the wheel of subdivisions round the centre, and deploying.—Sec. 34.

MANŒUVRES OF THE LINE.

A division of infantry deployed in order of battle may be reduced to a line of contiguous battalion columns.

This line may be formed into a mass of columns either to the front or to a flank.

Line may be re-formed to the front by deployment, or to a flank by the wheel of the battalion columns.

Changes in the position and direction of the line of columns may be effected by echellon or other methods.

The columns of which the division of infantry is composed, corresponding exactly to the companies of a battalion, and each manœuvre being precisely similar in principle to the corresponding battalion manœuvre.

When, therefore, an extensive line is to change its position, whatever may be the nature of that change, the general principle by which it is effected is the same.

That principle is—

To form columns of battalions.

To manœuvre with these columns so as to establish either their fronts or their flanks on the new alignment.

To re-form line by deployment, if to the front; or by opening out and wheeling, if to a flank.—See Part IV. Sec. 7.

It is not necessary to examine separately such movements of the line as are effected by methods similar to those which have been already noticed in connection with the movements of the battalion.

There are, however, some of the dispositions and movements of great bodies which are not analogous to those of a single battalion, and which, therefore, require separate consideration.

DOUBLE LINES.

In manœuvring a strong division, it is usual to dispose the troops in double lines parallel, and, generally speaking, conformable, to one another.

In effecting changes of front, the following simple method for preserving the parallelism of the lines is given among the 'Evolutions de Ligne,' in the French 'Ordonnance sur l'Exercice et les Manœuvres de l'Infanterie.'

The Officer commanding having determined the direction of the new alignment by means of a distant object (O), an Officer places himself at *f*, 50 paces from B; he then marches out perpendicularly to the alignment, till he reaches *e*, in the alignment B, O, where he is halted by a Staff Officer (S). B and *e* are the base points of the first line.

Plate II. fig. 4.

To trace parallel to it the new alignment of the second line (C, D), a Staff Officer having determined its distance by assuming the point P, a coverer is placed at *m*, 50 yards from P: this coverer paces (*m*, *n*) perpendicular to A, S, and equal to *f*, *e*.

P, *n*, will be the base points for the new formation of the second line, and the alignment can be prolonged by means of Adjutants and coverers to *x* and *y*.

CHANGES IN THE DIRECTION OF THE MARCH OF A MASS OF COLUMNS.

In changing the direction of a mass of columns, if, like the divisions of a battalion, each column wheels in succession at a fixed point, and then continues its march in the new direction, it is evident that the rear columns will be checked, and that

distances will be lost. No method is laid down in Part IV. of the 'Field Exercises' for avoiding these consequences.

Annexed are two modes of performing the manœuvre prescribed in the French 'Ordonnance.'

First method. The column is halted at some distance from the point where the change is to take place. The leading battalion then marches to the point, wheels into the new direction, and continues its march until it has traversed a space equal to the total depth of the column; it then halts. The other battalions follow in succession, each being put in motion when the preceding one has gained 40 paces to its front. When all the battalions have wheeled, the column resumes its march.

See Note 8.

Second method. Plate II. fig. 5. The column having arrived at A, and it being intended that it should pass the point D, and prolong its march in the direction D, S,—in place of the march of the column being directed on the point D, the guide of the leading division, on arriving at the points A, B, C, and D, under the guidance of the Officer conducting the column, successively turns into the directions A B, B C, C D, D S, and marches on the objects P, Q, R, and S. The guides of the rear divisions follow exactly the traces of the leading guide, each turning into the new direction at the points A, B, C, and D.

When the guides turn into a new direction, the other men bring their shoulders forward, and gradually conform to it.

If care be taken so to select the points P, Q, R, and S, that the changes of direction be not very abrupt, the direction of the column is altered without creating confusion or interrupting its march.

CONCLUSION.

In order to form a just idea of the grand manœuvres of armies, it must be remembered that the movements of large masses of men are of a mixed character, and that the changes of position of an army are effected partly by ordinary marches, and partly by systematically combined movements of the fractions of corps.

The leader of a strong division, having received from the Commander-in-Chief general instructions respecting the ground he is to occupy, and the manner in which his troops are intended to act, conducts his division along the roads which débouche on the point indicated. On arriving in its vicinity, he collects his corps in columns, and directs such manœuvres to be executed as are either suitable for developing his force according to the prescribed disposition, or as are rendered necessary by the circumstances in which he finds himself placed. The first part of this process—that of conducting the troops to the point of assembly—requires, *comparatively speaking*, little art or tactical skill. The difficulty consists in the second part of the process, that of arraying a mass of men according to a predetermined plan, and of making such alterations in this disposition as circumstances may require. This can only be effected when, through the medium of organization, systematic methods are made use of by a person of sufficient intelligence and decision to adapt these methods to existing circumstances. This is equivalent to saying, in order that a mass of men may be effectively employed in warfare, the mass must be composed of soldiers, and its leader must be a TACTICIAN.

The selection of points to be occupied or assailed, the determination of the force to be directed on each, and the indication of the lines by which great changes of position are to be effected, constitute that branch of the Art of War which is called the Science of Grand Manœuvres.

The arrangement of these grand manœuvres is the office of the Commander-in-

Chief, and depends on considerations quite unconnected with the training of troops, or with any particular system of evolutions.

But, on the other hand, the rapid and regular execution of these arrangements, which alone can render them successful, entirely depends on the existence of a well-organized system of evolutions, on the skilful application of that system by the Officers in command of corps and battalions, and, above all, on each individual soldier being carefully trained to obey implicitly, to move steadily, to form rapidly, and under no circumstances of danger or difficulty ever for an instant to forget that instinct of combination and immediate and implicit obedience which is the essence of military strength.

It is only when a body of men is thus constituted that its numbers become formidable, and its energies available for great achievements. Numbers without order, instead of contributing to strength, only serve to render more disastrous the consequences of weakness.

Valour without discipline, so far from being sufficient to secure success, has frequently no other effect than to precipitate the moment of ruin.

NOTES.

1. The word 'Tactics' is in this article used to denote the science of military formations and movements.

2. Without appealing to the experience of those who are familiar with what occurs in actual warfare, every one who has witnessed even a *Field Day* knows that firing has a tendency to loosen the files. If, therefore, the natural order were found to be the best, and adopted as the rule of formation, would it not follow that the divisions of a battalion ought to deploy with intervals between them, so as to admit of the files being loosened without confusion?

There is no tactical point of greater importance, or which is worthy of more careful investigation, than the determination of the most advantageous mode of occupying ground; that is to say, the extent of front being given, the determination of the number of men and the manner of disposing them, whereby the most effective fire can be secured for its defence.

The importance of this point being accurately determined will be manifest, if it be considered that both the development of the line of battle and the proportion of casualties have obviously a direct dependence on the density of the formation.

3. The means of keeping this force effective, or the determination of an establishment for the battalion which shall be adequate for supporting the casualties incident to military service, is a question which is perfectly distinct from the determination of its proper effective force. This question of the establishment which corresponds to a given effective force is both interesting and important; but it depends on considerations which do not belong to the subject of tactics (as defined in Note 1); it cannot, therefore, be discussed in this place.

4. If part of a line be marching on level ground and part on a slope, in order to preserve a correct alignment, the rates of march of these two sections must be unequal, since it is evident that the section on level ground is traversing the side, and the section on the slope the hypothenuse of a right-angled triangle.

5. One of the manœuvres practised in the French army is the wheel of the

battalion in line. The wheel and echellon march of battalions is one of the methods prescribed in the 'Ordonnance' for changing the front of extensive lines.

6. Supposing the battalion to consist of 800 men, if composed of eight divisions, the front of a division would occupy 35 paces, which, in order that the depth may not exceed the front of the column, requires that a division and its interval shall not occupy more than five paces. If organized in ten companies, the front of a division would occupy 28 paces, which, preserving this ratio between the front and depth of the column, would only allow three paces for a division and its interval.

7. The Roman legion has been often cited and studied as a model for the organization of large military bodies; it must not, however, be supposed that in the formation of the line of battle, each legion was always arrayed as a distinct corps, and that parts composing it were invariably kept together and disposed in the same order.

On the contrary, we find that the cohorts of different legions, like the battalions of different divisions, were sometimes detached, and arranged not according to any system of tactical organization, but in the way which was most suitable to existing circumstances. E. G.—Cæsar, in his 'Commentaries on the Civil War,' informs us that on one occasion, when manœuvring against Afranius, he drew up his army in three lines; that his first line consisted of 20 cohorts, four from each of his five legions; that his other two lines each consisted of 18 cohorts, viz. 3 auxiliary and 3 from each legion, or 15 legionary cohorts.

"Cæsaris (acies) triplex: sed primam aciem quaternæ cohortes ex quinque legionibus tenebant, has subsidiariæ ternæ, et rursus aliæ totidem, suæ cujusque legionis subsequebantur."—*Com. de Bel. Civ.* lib. I, lxxxiii.

8. The method of changing the direction of a mass of columns practised by the garrison of Dublin in 1844 was similar to the first of the two annexed French methods of performing this manœuvre.

THE MARCH OF INFANTRY CONSIDERED AS A BRANCH OF SPECIAL TACTICS.

"Tout le secret de la Tactique est dans les jambes."—*Les Rêveries du Maréchal Saxe.*

Not only when viewed in relation to the science of General Tactics, but also when considered as a branch of Special Tactics, the subject of marching presents itself under two different aspects; and in treating of the details connected with the marching of troops, as well as when treating generally of the movement of masses, it is necessary to keep in view the distinction which exists between marches of route and marches of manœuvre.

The objects of these two species of marches are essentially different; and in order to perceive distinctly, and to appreciate justly, the principles by which each species ought to be regulated, a definite idea must be formed of the nature of these objects.

I. ROUTE-MARCHING.

To traverse the greatest possible space in the least possible time, and with the least possible fatigue to the troops, may be defined to be the object of route-marching.

The variations of this maximum and of these two minima evidently depend on the strength of the soldier.

What is this strength able to accomplish? By what means may it be most effectually husbanded?

It is with reference to these questions that the fundamental principles of route-marching must be determined, and the regulations established by which it is to be governed.

Let us interrogate experience in order to ascertain what distance troops may be expected to march in a day.

History has recorded the length of the '*justum iter*,' or regular day's march of the Roman legionaries. We know that 20 Roman or 18·4 English miles was the distance fixed by the greatest military nation of antiquity as a fair daily task for the soldier. The complete alteration in the mode of fighting which has taken place since the invention of gunpowder, and the consequent modifications which the Art of War has undergone, render the practices of the ancients in many cases quite inappliable to the circumstances of modern armies; but the proper length of the day's march depends on physical circumstances, which during the lapse of ages have undergone no alteration; and since no troops ever surpassed the Roman legionaries in the frequency, the length, and the arduousness of their marches, so we may fairly infer none are better qualified to determine the proper limits of the day's march than the military legislators of ancient Rome.

Let us then assume on the faith of these great authorities that about 18 English miles is the minimum* which at all times, and during long-continued marches, ought to form the daily task of the soldier; but that during peace, and under ordinary circumstances, troops should not be harassed by journeys of a greater length than the distance fixed for the regular day's march.

It is a more difficult task to determine the maximum distance which good troops may be expected to march, when the exigencies of war require that their strength and energies should be taxed to the utmost.

Both ancient and modern history supply us with many examples of marches of extraordinary length: perhaps it may here suffice to quote one of these notable marches.

Napier informs us that the light brigade joined Wellington at Talavera the day after the battle, having, during the hottest season of the year, marched a distance of 62 English miles in 26 hours. This is an extreme instance, and shows what it is possible to accomplish when a single strenuous effort is required of good troops.

The state of the weather and condition of the roads must always exercise a great influence in determining both the advisable and the necessary limits of the day's march. These limits, therefore, cannot be otherwise than extremely variable and uncertain.

This uncertainty renders the combination of marches an element of military calculations, which is extremely liable to error, and which it is difficult to estimate correctly. Guibert justly remarks, "Many warlike operations fail from ignorance how to combine with precision the times, the distances, or the nature of the roads."

Let us now consider by what means the toils and fatigues of the march can be reduced, and the soldier's daily task performed in the easiest possible manner.

In this inquiry we can derive no benefit from the wisdom of the ancients. No account has been handed down to us of the minutiæ of their discipline, nor of the

* The strength of the soldier is not the only measure: the delays by baggage, artillery, &c. must be taken into consideration, which will reduce the 18 probably to 15.

precepts of detail by which their marches were regulated. . The best modes of training and preparing for pedestrian exercise are, however, well understood; many salutary regulations are at present in force to provide for the comfort and ease of the soldier on the march; and it is probable that others might be devised which would still further tend to promote these important objects.

The chief points to be attended to in the conduct of marches are—

1st. The equipment of the troops.

2nd. The order of march.

3rd. The rates of march and intervals of rest.

4th. Precautions to be observed at the end of the march.

A few observations on each of these points will conclude this review of the subject of route-marching.

1st. *Equipment of the Troops.*—This is not the place to enter into a general discussion respecting the costume and equipment of the soldier—to inquire whether the fashion of his uniform is well adapted for bodily exercise? Whether the weight of his kit is reduced to the least possible amount? and whether the burden he has to bear is arranged and suspended according to the most scientific principles?

These inquiries are highly important, and have a direct bearing on the soldier's capacity of enduring fatigue; but it will here be sufficient to notice that part of his equipment which has the most immediate and essential connection with the subject of marching,—viz. the clothing of his feet.

Too much care cannot be taken that the soldier's socks be thick and soft in their texture.*

That his shoes have strong broad soles and low heels; that they fit easily, and that previous to a march they be softened with grease.

Rubbing the feet with soap is also recommended as a method of preserving the feet. On the due observance of these and similar precautions the condition of the soldier's feet principally depends; and as the majority of men who fall out on the line of march are disabled, not by fatigue, but by sore feet, it is obvious that no part of the interior economy of a company should be more carefully superintended by its Officers than the state of the men's shoes and stockings.

2nd. *Order of March.*—On the line of march, when no enemy is at hand, it is the custom of all armies to free the soldier as much as possible from the restraints of the parade ground. To loosen the files; to open the ranks; to allow the men to carry their arms as they please; to abandon their measured pace; to converse with each other; and, in short, to trudge along as cheerfully as they will, and as easily as they may. Such is the extent of the licenses which the regulations of the Service grant the soldier at the word 'March at ease:' perhaps the principle on which these licenses are granted under certain circumstances admits of being carried out a step further.

In time of peace, when to move from point to point (not to manœuvre) is the object of the march, and when between one halting-place and another no formation is contemplated, why should not the sections march at double or even treble distance?

In the march of a strong column, inconvenience might arise from thus doubling or trebling its length; but in the case of a regiment or a detachment, no inconvenience would be felt from so doing.

By increasing the distance between the sections, and by taking care that, when

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* If this cannot be secured, better take off the stockings altogether.

formed at close order, their front should not exceed half the breadth of the road, crowding and jostling would be avoided, and the greatest possible freedom from dust and heat secured to each individual soldier.

It is scarcely necessary to remind any one who has marched with troops how a song with a chorus, or a lively air played by the band, invigorates the drooping spirits of tired soldiers.*

3rd. *Rates of March, &c.*—In order to march a given distance with the least possible fatigue, it is of great importance that the rates of march and intervals of halt should be properly regulated. If the rate of progression be very rapid, the strength will be exhausted by the violence of the exercise; and if very slow, will be worn out by its long continuance.

Between these extremes there must be a medium rate of march, which is the most favourable for husbanding the strength, and by using which a given distance will be accomplished with the least possible fatigue to the soldier.

In order to determine this medium rate, it would be highly desirable to ascertain by an extensive series of careful and varied observations on the march of troops, what degree of quickness of step is least fatiguing to the soldier, and most easily sustained by him throughout a day's march in heavy marching order.

It would be also useful and interesting to determine by accurate experiments the absolute rates of march, or ratios of distances to times, which correspond to different degrees of quickness of step.

These investigations would not only furnish useful data for regulating the conduct of marches, and for the calculation of military movements, † but would also serve as a basis from which principles and considerations might be deduced for selecting and combining that length and that quickness of pace which are most suitable for the attainment of precision and uniformity in manœuvring.

Table No. II. presents a comparative view of the rates of march established by regulation in the armies of several different nations. Judging from the want of uniformity in this fundamental part of the soldier's training which the Table exhibits, it may be presumed that the discovery of some principle to fix the proper standards for the length and quickness of the military pace is still a desideratum in the Science of Tactics.

Of these two elements which enter into the composition of a rate of march, it is evident that one—viz. the length of the pace—has a functional dependence on height, and will therefore, when not artificially regulated, of course vary in different individuals.

The annexed Table shews the results of some experiments made by the writer of this article with the view of determining his own rates of walking.

It indicates that the length of the pace is very considerably modified by its quickness, and that as the rate of motion is accelerated, the length of the pace is increased, though not in a uniform ratio. If, as seems probable, the *ratio* of this increase is in a great measure independent of height and other individual peculiarities, this relation between the length and quickness of the pace is worthy of being accurately investigated, and ought certainly to be considered, and, if possible, preserved in constructing artificial rates of march for military purposes.

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* Attended to more in Foreign Services than in ours.

† Some principle might be established of *never* loading the soldiers with more than one day's biscuit and 30 rounds of ammunition, except on very urgent occasions, and loading bât-horses with the complement of both, instead of harassing the men.—*Editors.*

TABLE I.

Lengths of Pace and Rates of March corresponding to Steps of different Degrees of Quickness (the height without boots being 5′ 9″).

No. of steps per minute.	Variations of like Pace.				Rates of March.		
	Length of pace (inches).	Difference from mean length=32·71 (inches).	Difference from preceding value (inches).	Ratio of successive differences to mean length of pace D : 32·71″ :: 1 : *x*.	Yards per minute.	Miles per hour.	One mile in — minutes.
100	31·06	−1·65			86·28	2·941	20′ 23″
108	31·01	„ 1·70	− ·05		93·05	3·172	18′ 55″
115	32·19	„ ·52	+1·17	27·95	102·83	3·619	17′ 7″
120	33·73	+1·2	1·54	21·29	112·47	3·834	15′ 39″
125	33·8	„ 1·9	·07	467·3	117·37	4·001	14′ 59″
130	35·08	„ 2·37	1·28	25·55	126·68	4·318	13′ 53″
Average	32·71						

Note.—The values given in the Table are averages deduced from repeated observations of the times of traversing known distances. During each set of observations the distance traversed varied from 14 to 17 miles.

If accurate Tables similar to the above were formed from sufficiently numerous observations on the march of troops in heavy marching order, then by a simple reference to the number of paces per minute, (an element which is easily ascertained and controlled,) the duration of marches might be estimated, and their rate regulated with very great precision.

A rate of march being determined suitable to the circumstances of the case, and the nature of the object to be attained, its conformity would be easily preserved by making an officer or non-commissioned officer march at the head of the column, and regulate the quickness of the pace by occasional reference to a watch.

The duration of halts and the proper intervals between them must have considerable influence in modifying the fatigues of a march. In the Standing Orders of the Light Division, most of which, we are informed by the Editors, originated in observations made in the field by the late Major-General R. Craufurd, it is directed, "that the first halt of a column shall take place half an hour after it marches off, and that afterwards at the end of every hour it shall halt for at least five minutes."

4th. *Precautions after the March.*—With a view to the preservation of the men's feet, it is the custom in some regiments, immediately after the conclusion of the day's march, for the Company Officers to go round the billets and see the men paraded without shoes and stockings, in order to ascertain that their feet have been properly washed and cleaned. A Medical Officer also visits the billets and dresses the feet of such of the men as are badly blistered.

As it is not always possible for a Surgeon to perform this duty, perhaps it might be useful to promulgate a few simple directions, pointing out the best way of treating blisters, and to commit the enforcement of these directions to the Company Officers.

II. MARCHES OF MANŒUVRE.

It is necessary that separate bodies manœuvring together should move at the same rate, in order that the proper intervals may be preserved between divisions, and that tactical combinations may be executed with precision.

It is also necessary that the soldiers of a division should move at a uniform rate, in order to prevent the files separating from one another, and thereby deranging the correct dressing of the line, on which the direction of the march of the division, and consequently the accuracy of its movements, entirely depends.

From these considerations, with reference to the purpose of this article, it follows, that in manœuvring, *Uniformity of Motion is the principal object to be attained.*

This renders the march of troops, when executing military evolutions, perfectly different in its character and principles from those marches which have no other object than to move them from one place to another.

In manœuvring, the rate of march is no longer a measure of the strength of the soldier, varying according to the quality of the troops and the circumstances which affect their ability to sustain the fatigues of the march, but is a uniform rate strictly defined by regulation, and at all times and under all circumstances among the soldiers of the same army remaining perfectly fixed and invariable.

In order that the motion of a body of men should be perfectly uniform, it is evident that the cadence and length of the pace of each individual must be precisely the same.

Accordingly, in all highly disciplined armies the careful training of the recruit to such a measured pace, regulated by the constant use of the plummet and pace-stick, is the basis of the whole system of tactical instruction.

In these artificial systems of marching, the motion ought to be entirely from the hips, and the length of pace ought never to be so great as to cause the slightest derangement of the steadiness of the body and squareness of the shoulders.

In all existing codes of military instruction, two principal rates of march, termed by the French '*pas cadencés*,' are taught the recruit.

The slower or fundamental rate is used in teaching the principles of marching in parade movements, and in those manœuvres, such as the march of lines, where the greatest precision is required, and where individual irregularities have the greatest effect in disturbing the movement of masses. The other rate, in some Services termed the 'deploying step,' is that which is habitually used when the manœuvre is executed by a combination of the movements of divisions of a small extent of front.

Regularity, not rapidity, is the principal object to be attained in ordinary manœuvres, and the regulation pace ought never to be so quick as to cause the slightest hurry, crowding, or confusion in the ranks.

In addition to these two principal rates of march, in some armies troops are drilled to a running pace, applicable to certain special exigencies of warfare.

This is a very useful part of the instruction of the soldier, for, although in making a rush to seize a contested point, it is probable that no discipline will equalize the step of the bold and the timid, yet in many circumstances—such, for example, as sudden formations against cavalry—both great regularity and great expedition are absolutely essential to the safety of infantry.

Guibert, in his admirable Essay, makes the following observations concerning this rate of movement:—

"The treble or running step cannot be restricted to any fixed degree of quickness,

because its quickness ought to vary in proportion to the importance of forestalling the enemy, the distances to be traversed, and the object to be attained after traversing these distances. I consider it as the step to be used in all cases where a great acceleration of speed is necessary.

"Therefore, in order to forestall the enemy on an essential point, to turn his flank, to deploy, and be prepared to charge before he is formed, the rate of this step should be carried to its utmost limits; but in such cases the soldiers must not be expected to maintain equality of step, uniformity of time, or the symmetrical order of the files: it ought to suffice if they advance in silence, if the files are kept separate, if they do not get before their officers; and if at the word '*halt front*' they close in, halt, and regain their places."

There is another observation of Guibert's which is worthy of notice, as illustrative of the nature of the considerations which determine the character of the march suitable to military evolutions.

He says, in great manœuvres, when large bodies of troops change their position, many of the divisions having to traverse broken ground and to march considerable distances, that to subject the men to the constraint of a measured pace is, under such circumstances, neither necessary, nor is it practicable. That such movements should, during the greater part of their extent, be conducted on the principles of ordinary route marches, and that it is only when the march of each battalion is near its termination, when it is about to deploy, or to enter an alignment, that its compact order should be restored, and the regulation pace resumed.

Different nations have adopted different standards for the regulation both of the length and quickness of the military pace.

The variations of these standards (as will be seen by reference to the annexed Table) are by no means inconsiderable.

Comparing the lengths and rates given in it with those of Table I., and assuming that the allowances which must be made for the effect on the length of the pace caused by the weight of a knapsack, and by the difference between five feet nine inches (the height given in the Table) and whatever may be the average height of the army, would not materially affect the results there shewn; taking it for granted also that these results present a tolerably near approximation to the natural relation which subsists between the length and quickness of the pace corresponding to the height and degrees of march given in the Table,—then it will be observed that the proportions of the British quick-step are more consistent with this natural relation than the military steps of any of those nations with which it has been compared.

And since the constraint of stepping short is quite as harassing as the exertion of stepping out, it cannot be doubted that in those systems, such as the American, and especially the Spanish, where a very short has been combined with a very quick step, that this violation of a physical law must have an injurious effect in increasing the difficulty of training the recruit.

It may also be noticed that the British and Prussian paces are those which approach most nearly to the length of the military pace of the ancient Romans.

TABLE II.

Lengths of Pace and Rates of March established by Regulation in several different Armies.

Name of Nation.	Name of pace.	Length of Pace.		Rates of March.	
		Foreign Measures.	British inches.	No. of paces per minute.	Yards per minute.
British . . .	Slow step		30	75	62·5
	Quick step		do.	108	90
	Double step		36	150	150
French . . .	Pas ordinaire	65 centimetres	25·59	76	54·02
	Pas accéleré	Do.	do.	100	71·11
	Pas redoublé	Not given.	not given	140 to 150	
Prussian . .	Ordinairer schritt	2 fuss. 4 zoll. Rhinland measure	28·83	75	60·06
	Geschwind-schritt	Do.	do.	108	86·49
	For the charge	Not given.		120	
Austrian . .					
Russian . .					
Spanish . .	Paso regular	2 pies	22·25	76	46·97
	Paso redoblado	Do.	do.	120	74·17
United States.	Common step		28	90	70
	Quick step		do.	120	93·33
Ancient Roman	Passus Militaris (½)		29·18		
Average . .	Slow step		27·31	78·4	59·47
	Quick step		do.	111·2	84·36

Note.—The length of the Roman pace has been calculated on supposition of there being 75 Roman miles of 100 double paces to a degree. The Prussian rates of march have been taken from Scharnhorst; the others from the Regulations of the different Services.

In making the reductions the following values have been adopted:

Metre . . . . . =39·37 inches.
Rhinland foot . . =12·356 „
Burgos foot . . =11·128 „

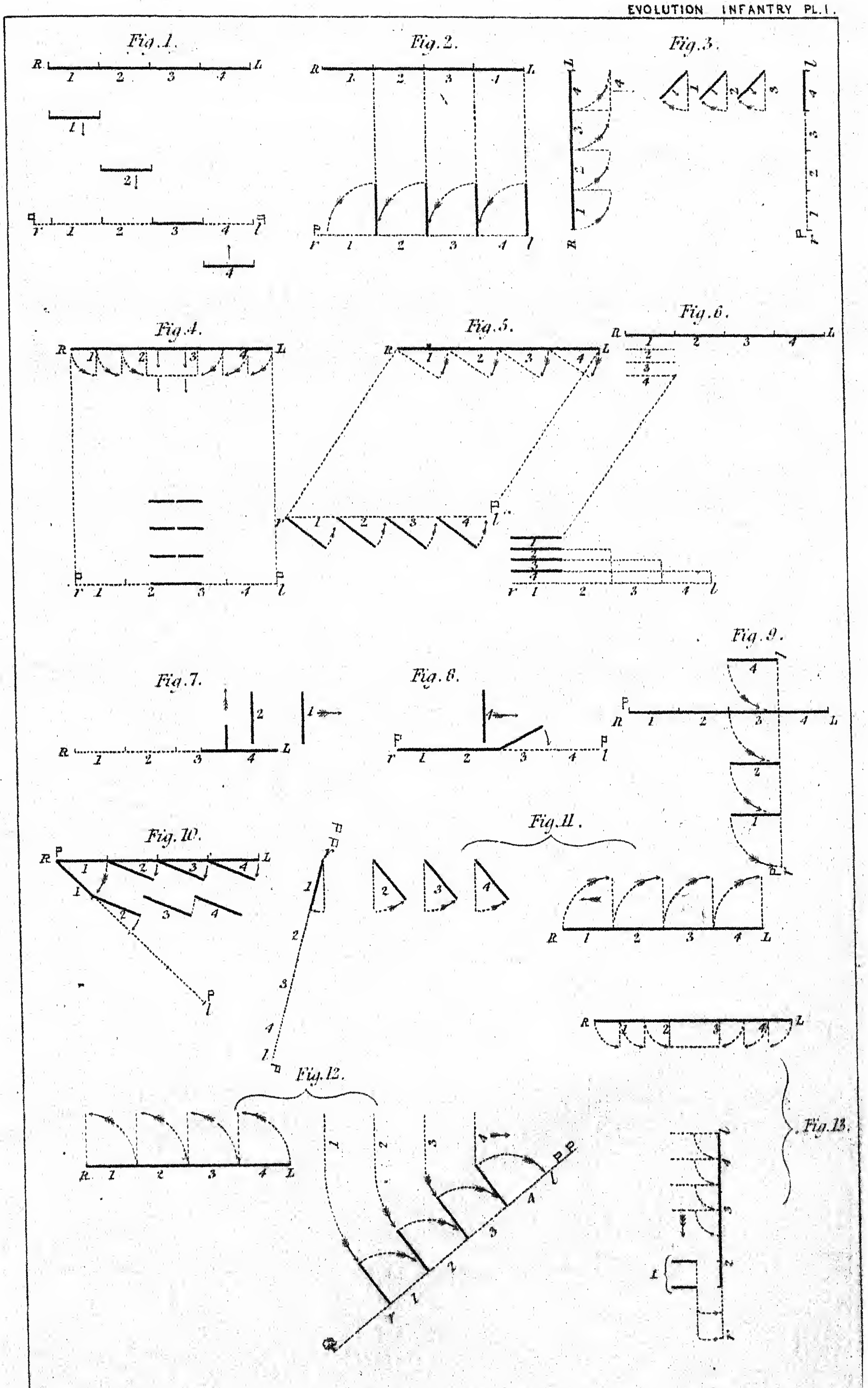
EVOLUTIONS OF ARTILLERY.*

ARTILLERY ACTING WITH OTHER TROOPS.

1. When artillery is attached to other troops, and its movements are to be regulated by them, the Commander should manœuvre so as not to interrupt them.

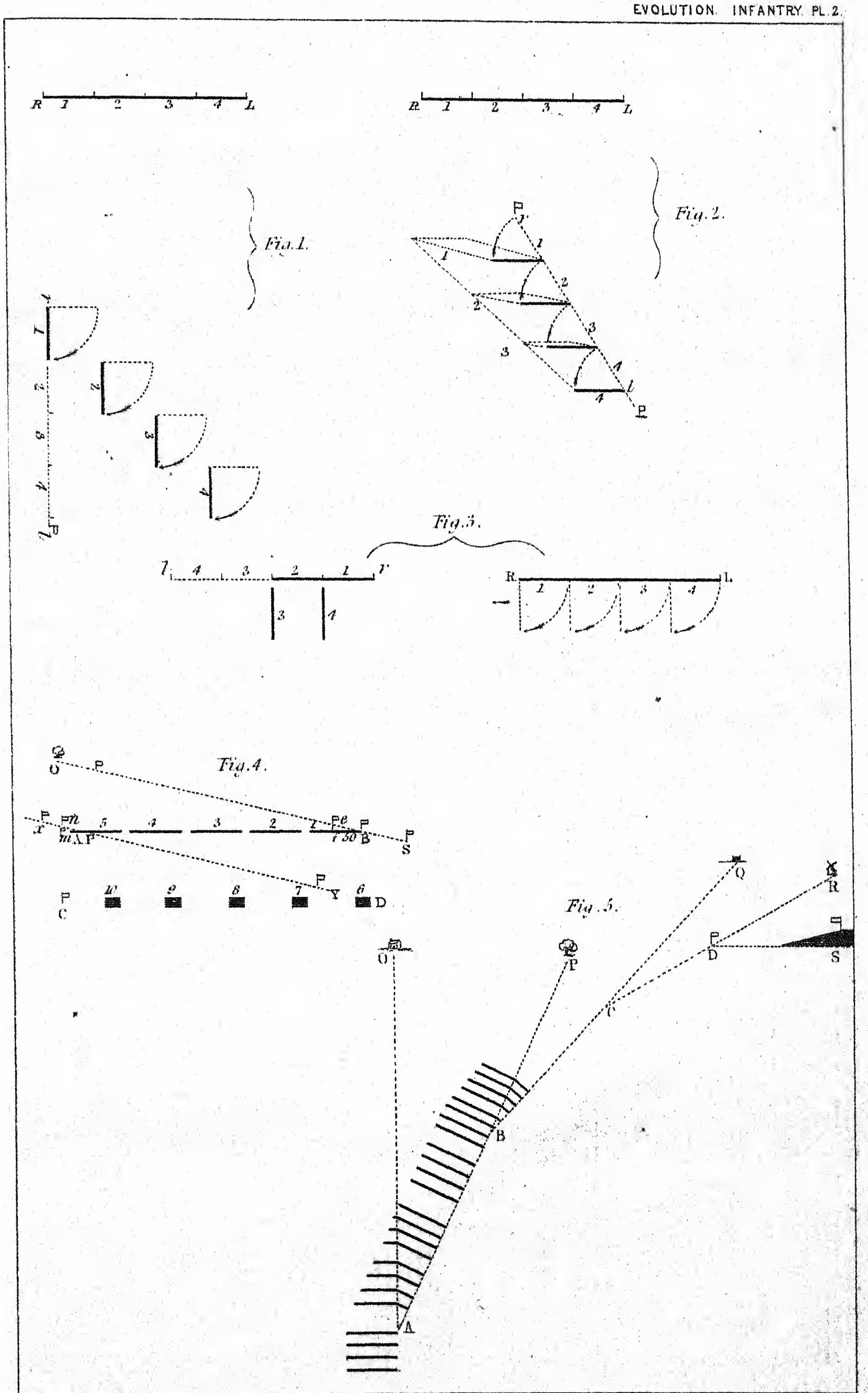
2. He (as well as every other Officer) should be well acquainted with the evolutions of troops, for he will then know the ground which they will go over in performing

* From 'Instructions and Regulations for Field Battery Exercise.'



A. C. Robertson del. J. W. Lowry fc.

John Weale 59 High Holborn 1846.



A. C. Robertson del. J. W. Lowry fc.

John Weale, 59, High Holborn, 1846.

any manœuvre, and will never impede them; moreover, he will be enabled to arrive more quickly at the position he is to occupy.

3. Though in matters of review the artillery should generally conform as nearly as possible to the movements of the troops, yet a latitude should be given to the Commander to depart from this rule whenever he may see it necessary, and when he thinks he may attain his object by acting differently.

4. In all alignments of troops, the artillery should never be brought up nearer than sixty yards from the intended alignment, till the points of it are finally established, when the Commander will move it up to its position, twenty yards in rear of the line, where it will remain: by this means, should the whole move to a flank, the artillery will be clear of the line of pivots.

In Line.

5. When the artillery is ordered into line, or, at review, when the General is about to appear, Nos. 1 of each subdivision move out, and place themselves one pace and a half in rear of the front rank of the troops, and facing to their subdivisions. The artillery move forward, Nos. 1 halting their subdivisions when the leaders come up to their own persons.

6. Should the artillery be ordered for action, and be required to fire, it will move forward previous to its unlimbering.

7. When the guns are in action, the axletrees are to be in a line with the front rank; and when they are ordered to limber up to the front, they must be run back so as to leave the alignment clear.

8. The artillery should always cover the troops when advancing, retiring, or deploying into line.

9. In line, the artillery will generally be placed on the flanks of the troops to which it is attached; and if there be no other troops on its outward flank, there will be sufficient room for it to move freely. When, however, it is to be drawn up between two bodies of troops, it must manœuvre as much as possible on its own ground. The Table at the end* shows the number of yards for a battery of six guns in line and in column. With less, the artillery will be confined.

10. The distance which artillery can move in advance of a line must always depend upon the support it can receive from the troops or covering party, and from the nature of the ground. The Commander must always be guided by the position and manœuvres of the enemy. Should there be any favourable positions, or risings or swells in the ground, advantage should be taken to place the limbers under cover.

11. If the line is to advance after deployment, the artillery must gain ground to the front, while taking ground to the flank to uncover the troops as they deploy.

12. When the line advances and approaches the battery which covers the advance, the Commander will, in proper time, push forward the half-batteries alternately, either limbered up or with the prolonge.

13. When artillery is in action on the flank of a line, it should, in general, be placed more or less in echellon, in order to bear obliquely on the enemy in front.

14. When the line retires by alternate companies, wings, or battalions, the artillery must remain with that part of it which is nearest the enemy; retiring with the prolonge, and halt when it arrives with the halted part of the line.

15. When the line changes front to a flank on its centre, the artillery, with the flank thrown back, should cover it, retiring with the prolonge; the artillery on the other flank covers its advance.

16. When the line is thrown backward or forward on one of its flanks, some of the guns nearest the halted flank may be run into line by hand.

* See 'Instructions and Regulations for Field Battery Exercise.'

Column. 17. When the troops are in column, the artillery should be on the reverse flank.

18. If the artillery be at the head of the column, and from obstacle or a narrow road, it becomes necessary to diminish the front, it should be done before the head of it arrives at the spot, so that no delay may be caused in the rear.

19. Whenever the ground becomes too narrow for both troops and artillery to march on the same front, the artillery should endeavour to get to the head of the column, or it will probably have to wait till all the troops have passed.

20. When a line of troops wheels backwards into column, the artillery, in breaking into column, must close to the reverse flank, so as not to interrupt the line of pivots. When the column is put in motion, the reverse guns open out to the proper intervals.

21. When there are troops both in front and rear of a column of artillery, and that, in order to facilitate the movement, the carriages go so far to a flank as to leave the space between the two columns of troops entirely clear, two markers should be posted just within the line of pivots, to mark the situation of the flanks of the artillery, and to preserve a proper distance for it between the columns of troops.

22. In column, with troops both in front and rear, the artillery should never open out, if it can be avoided, to more than the distance it stands upon in line.

23. The infantry generally wheels backwards from line into column. If the artillery wheels forward, instead of breaking into column, there will be a false distance between the rear of one and the front of the other. The Commander of the artillery must correct this by slackening his pace.

24. It is always essential to procure sufficient room for artillery to move in, and when between two columns of troops, never to crowd the carriages so much as to diminish this space.

25. When the troops are in line of contiguous battalion columns, the artillery should be in line on the flanks of the line of columns, at the usual distance of 20 yards from the front of the leading companies of battalions.

26. When a mass of columns, or a line of contiguous columns, advances previous to deployment, the artillery must be pushed forward to the position which it is to occupy when the line is formed.

27. When the troops retire in column, the artillery should retire on their flank, when the ground will permit; but if the column enters a road or défilé, the artillery which is to cover it must place itself in the rear, retiring with the largest possible front.

Squares. 28. For the position of artillery when the infantry form squares, see Article 4.*

29. It may be as well at reviews not to fire when riflemen or other troops are in front of the artillery; although, in reality, the guns can with safety fire round shot, if necessary, over their heads, or through any large intervals which may be between the advanced bodies.

30. When the roads are good, or even tolerable, the artillery is always obliged to wait for the infantry, which is attended with much additional fatigue to the horses, from having their harness so much longer upon them. When, therefore, there is no danger, the artillery should be allowed to regulate its own rate of marching.

31. One of the most important objects that can be attended to is the march, when troops are to assemble at a fixed time and place. The Commander of artillery may, with judgment and experience, save much unnecessary fatigue to both men and horses by taking into consideration the state of the weather and roads, and regulating his movements accordingly.

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* This alludes to another part of the work from which the extract was made.

EVOLUTIONS OF CAVALRY.—See 'Manœuvre.'

F.

FASCINES.*

The two descriptions of fascines used in sieges are those for revetting and tracing. Great care and some practice is necessary to make long fascines well and expeditiously. They should be, when finished, straight, cylindrical, and pliant; bound round with good thick unbroken gads, or withes, at equal distances of not more than 9 inches asunder, the knots well tied, and all in one line: no variation in the girth, exceeding 1 inch, to be allowed.

Much depends on, and much time will be saved by, attention in the first instance to the fixing of the trestles firmly and accurately. The two stakes are usually tied together with rope or twigs; but they will be much steadier if fastened by a wooden pin. The rope-lashing may then be added with advantage, particularly if it fills up somewhat of the angle, thus giving a better shape to the fascine. It is of consequence to have the stakes for the trestles of squared wood, as being more easily arranged with accuracy; and great care must be taken that they cross at right angles, and that the intersections cover well in line. The ground should be level, and the trestles not more than 2 feet 6 inches apart. The stakes may be ripped out of old 3-inch platform plank, in battens 4 inches broad; and if required for any length of time, the whole set of trestles may be kept steady by strips of wood running along, and nailed to them, outside.

No dry wood should be used in the fascine, if green can be obtained in sufficient quantity. The longest and straightest stuff outside, the more irregular and the smaller within. There should be plenty of small brushwood to give compactness by filling up interstices. The largest branches may be 1½ or 2 inches thick at the butt.

Fascines for revetting must be made at once of the proper length, and not sawn off at the ends, except when for embrasures, where the inside ends must be even. Not only should revetting fascines be left rough at the ends, but the ends of the branches should be cut to a slant, so that when forced into each other, a better joint may be more readily made. All leaves must be stripped, but the twigs may remain.

The gads must be of the most pliant wood that can be procured; if possible, from 1 to 2 inches thick at butt. They are twisted and wrought until pliable. The 'eye' should be made as soon as a sufficient length for binding is secured, and not left as a matter of course to the very smallest part, which the men are apt to do, to save themselves trouble. If, as with oak, the wood does not twist readily, it can be softened by being passed through the fire. To preserve the suppleness of the gads, they may be kept in water.

Four men are enough for a revetting fascine; two prepare the stuff, two arrange it on the trestles. They should make one of eighteen feet in three hours.† They

* From the Notes of Lieut.-General Sir J. F. Burgoyne, written at Ciudad Rodrigo in 1812.

† In the preparations for the siege of Bayonne, 1814, the Portuguese parties of the Line, employed on fascines and gabions (on which kind of work they are regular, diligent, and particularly clever), made at the rate of twelve 18-feet fascines every six men per day, at one set of trestles, besides their proportion of pickets (84); the stuff, which was very good, being 'delivered;' and the bands of spun-yarn. They were paid 8*d.* for each 18-feet fascine with its seven pickets. It made little

will require four bill-hooks, a fascine choker, a mallet, and gauge sticks for proper dimensions of their work.

When sufficient stuff has been laid on the trestles, the choker is passed round at about 10 inches from the ends, and pulled by two men until an inch or so less in girth than it is intended to be. It is then tied close to the choker, or at 9 inches from the ends. The binding then proceeds from the ends to the centre. Binds, 9 inches apart.

The usual mode of tying the knot is by passing the thick end of the gad through an eye in the small end, and then twisting the thick one round itself in a kind of oblique spiral; but this will frequently loosen, particularly if left exposed to the sun; besides which, the eye is very apt to break by its sharp bend, and the strain upon it. The knot will be better tied by passing the thick end (previously well twisted) *round* the eye, and then doubling it under the side of the gad, by means of a little pointed stick of hard wood, by which the greatest stress is laid on the thick part, instead of on the weakest.

When spun-yarn can be procured, it will save time, and does away with the most difficult part of the operation. The band should then consist of four yarns, passed twice round the fascine, besides the knot.

It is of little consequence how fascines are made which are not for revetting, so that they are tolerably compact and firmly made. Anything of nearly the proper length, tied in two places, will do for tracing fascines. These are generally considered as fatigue-work: the parties only take out bill-hooks, and tie the fascines as tight as they can, without chokers; and, instead of trestles, lay he stuff between two pair of upright stakes, a foot asunder, fixed into the ground just to support the stuff until tied. Large parties may be sent out, and tasked at two or three 4-feet fascines per man. Cavalry ought to take their share of this duty; and, if they can be spared with their horses, might be sent for gads, which are frequently more difficult to be found. They should be brought in bundles, of fifty each, 4 feet 6 inches long, and as thick as they can be had, to the size prescribed.

Tracing fascines are of the greatest service; and indeed, in parallels, almost of absolute necessity, as they make it easy to preserve a banquette, which it is nearly impossible to do without them.

Fascine pickets are also usually considered fatigue-work. They may be brought in without points, but something longer than the actual length required, and the straighter the better. They are only required for revetting, and at the rate of seven per 18-feet fascine.

FIELD SKETCHING:—chiefly in reference to military purposes, though also bearing on what are more technically called 'Field Sketches' in General Surveying.

This subject will be considered in four Sections.

I. Notices on the Apprehension of Ground.

II. Preliminary Arrangements and Instruments, &c. necessary.

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difference, as to time, whether they used spun-yarn or willow gads. The above party made eight 18-feet fascines in six hours easily.

Very great allowance, however, must be made at first starting with English soldiers; and reckoning on future improvement, so arrange prices that they may, with encouragement for the present, eventually earn from 15*d.* to 18*d.* per day, by diligent exertion.—J. F. B.

III. Sketching at leisure, and under no restriction from the neighbourhood of the enemy.

IV. Sketching against time, and in the neighbourhood of the enemy.

SECTION I.

NOTICES ON THE APPREHENSION OF GROUND.

The agencies to which so much of the present nature, extent, and arrangement of geological formations are due, are still busied in perpetual, though, generally, very gradual changes on the surface of the earth in its Topographical Character; hence the forms of ground that usually occur may be reduced to the following classification:

Those last produced on various materials by the action of	A. Air,—as in sand-hills, *e. g.* in the Deserts and south coast of Africa; or in sand formations like the super-marine portions of coral islands and belts; *e. g.* Bermudas, Bahamas, Pacific Ocean groups, Red Sea and Persian Gulf islets, &c. B. Water,—as in districts (other than the above) where no traces of volcanic action are visible. C. Fire,—as in volcanic districts. D. Of B and C conjointly,—as in districts of extinct and submarine volcanoes, *e. g.* the south-east of Sicily; or in now extinct volcanoes that have burst through B, as in the Eifel, Auvergne, &c.
Those composed of organic structures	E. Animal and Vegetable,—as in coral formations now in progress. F. Vegetable,—as in peat formations now in progress.

With exception of the immediate results of fracture from a central point, or along a line of disruption, nearly all the preceding forms are referable either to the actions of fluids and liquids on yielding matter, or to matter having been in a state of fusion; all bearing the stamp of 'fluid,' either as the physical character of the immediate cause of dispersion and subsequent re-arrangement, or as the original condition of once melted mineral substances. This relation to FLUID ACTION can rarely be lost sight of, whether in the instance of air on sand,* of water on earthy subjects, or of fire in the fusion of lava torrents.† And there is a characteristic resemblance observable in all three classes accordingly; but for most purposes it will be enough to consider B and D only, regarding the peculiarities of the remainder, however interesting, as rather matters of curiosity than of practical importance.

At the present day, it is unnecessary to shew that all formations, from the tertiary downwards, and much of the post-tertiary, have been under water; and that B and D became, on the whole, decided and fixed on their emergence therefrom: hence, to obtain the forms characteristic of B,‡ excellent studies may be found in natural models of a large extent of country on muddy shores, from which the water has just receded. Here we find mimic mountain ranges, then their subordinate hill districts, and these last passing insensibly into the gentle undulations of the last hillocks as they are finally lost to sight under bogs, marshes, or like level deposits, or in the sea

* The forms of well-settled and frozen snow, subject to gusts of wind sweeping down the ravines or valleys, on the bottom of which it lies, have at times a close resemblance to hill forms; very different from the fantastic shapes of newly-fallen snow, which agree well with those of sand-drifts.

† One of Hecla's streams is mentioned by Lyell as upwards of 90 miles in length.

‡ The instructive and beautiful little models of Mr. Dawson (well known to Engineer Officers of the writer's standing) relate principally to forms of this class and D.

Plate III. itself,—the valley and the ravine, the river and the streamlet, the lake and the pool, and nearly all the topographical features of aqueous formations acted on by water, both as to original formation and to subsequent abrasion. The defects lie in these representations being somewhat exaggerated where the mud is very soft and the bank rather steep; and also in the absence of such main features as are given by the bold intrusions of igneous rocks; though, when these are modified, as in D, by aqueous agency, they are represented with considerable fidelity.

With regard to Class D, remarkably defined and instructive studies from nature will be found in the Irish mountains, which are nearly all disposed in isolated groups, separated from each other by flat lands, a large proportion of which is bog.

On whatever scale the subjects of study may be,—

The master-lines of ground are,

1st. The main or summit ridges of the mountain or hill	Referring chiefly to classes B and D.
2nd. The water-courses	
3rd. The coast or horizontal contour lines .	. Referring to all.

The subordinate lines are those more or less oblique contour lines defining the minor features, and generally called feature lines.

ORDERS I. AND II.

THE RIDGE AND THE WATER-COURSE.

Plate I. In aqueous formations there is always a close conformity of parallelism between these two lines, as in Plate I. fig. 4, between N O and L L′ or M M′. In those of igneous character there may be only a very general one between the crest of the upper regions and the lines at the base; though, as we descend, this parallelism increases till the lower grounds are reached, which being usually composed of B or D, again admit of the above-mentioned " close conformity."

In reference to these two orders of lines, the first thing to be done in rock and clay formations (excluding both diluvial* and alluvial flats from the latter) is to study well the general character of the district in relation to the nearest mountains or Plate III. extensive hill range, so that the representations may have the force of truth, and be well characterized by a significant reference TO THE WHOLE, *of which it is but a part*, as far as the extent of ground permits. This is indispensable in plans of considerable tracts of mountainous or hilly country; and where several persons are to be employed in its execution, there must be one guiding head, to give this speaking character, and one qualified to insure its observation in all the performances of the assistants. In small portions of ground, such as a camp, an ordinary position, or battle-field, &c., these considerations are not quite so important; but still the spirit, clearness, and simplicity of the work, will always be more or less dependent on this principle being borne in mind.

In formations of loose sand and gravel (like those extending from the east of Holland, for upwards of 1000 miles, across the north of Germany, into the heart of Red Russia, skirting the northern slopes of the Hartz and Bohemian mountains, without a hill exceeding 400 feet in height,) this relationship between the mountain range and its lower members soon disappears; and the character of such ground is best obtained by studying carefully delineated charts of shallow seas, or like formations, such as those of the German Ocean, especially towards the coasts of Holland and the Straits of Dover; the hills being in this case without any very obvious relations, either as successive and subordinate heights, or as to lateral connection.

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* This expression is still retained for post-tertiary level grounds, senior to what is obviously alluvial.

Water-courses. The forms produced by water-courses descending from each side of the ridge (called also the 'Water-shed' line, from thus parting the waters,) are but few in number, being dependent on the relative positions of the streams as they find their way down to their 'primary'—the principal river—on its course to the nearest lake or sea.

Whatever may be the size of the stream, whether it be the largest river or the smallest streamlet, or the miniature channels traced on the mud-bank model, there exists, from the nature of the case, like results from like causes under like circumstances: thus the water-shed line under consideration may be the crest of the Apennine chain, or it may be the scarcely perceptible swelling of ground determining the direction of small rills to the different parts of a farm.

Plate I. fig. 1. Streams descending slopes will (normally speaking) either be perpendicular, as *a b g h* to the water-shed (W X), or they will be oblique to it, as *c d e f.* Any two of these, taken together, will give the elementary forms of water-courses; thus *a* and *b* give A, as the type of the Douro and Tagus, or better, of the Tagus and Guadalquiver, or of parallel rivers in their general course. B, the result of *c* and *d*, corresponds to the confluences in which rivers more or less originate, as those of the Punjaub, at the head of the Indus; in the same way that C (or *e* and *f*) represents the delta-shaped divergence common at the mouths of large rivers, as the Nile, Indus, Ganges, &c.

Plate I. In fig. 2, relating to the valleys of streams on a far smaller scale, as these streams descend, the valleys deepen—hence the side slopes, *a b*, *a b*; and these, truncated by the valley (Y Z), to which they are tributary, present the front slopes *b b*, *b b*. These direct courses, however, seldom continue long, as may be observed at the bottom of the sea, where the currents are constantly being deflected by various causes; and these (or the like) forms may be variously combined, as in fig. 3, where the first diagram is composed of A and B; the second of A and C; the third (a very common one) of D alone, or of B and C; the fourth of C and B; and so on. A further extension and combination of these water forms is shewn in fig. 4, the entire shape of which, as given by the two rivers L N, M N, is itself a compound of A and B, as in fig. 3, just as may be further exemplified by the Tigris and Euphrates; or as the union of A and C give the approach of the Don and Wolga, near Sarepta, before they finally separate for the seas of Azof and the Caspian respectively.

Fig. 3.

Fig. 4.

Thus, continuing this sort of action, we find that, generally speaking, the construction of hill-ground, as far as water-courses are concerned, is produced by the continual division and subdivision of main valleys by secondary valleys; of secondaries by those of a third order, and so on, till the process is terminated to the eye by the hills disappearing under some level, as the Rhenish hills do under the flat grounds of Holland, near Bonn, or the Welsh hills between Cardiff and Newport, in the red marl flats; or else by their reaching the sea or a lake: though to a great extent the same forms are found under water as above it, with this main difference, that they are still submitted to the action of the same power to which all topographical formations of class B have owed their existence.

Plate III.

Pl. I. figs. 5, 6. In illustration of the above, figs. 5 and 6 are general diagrams of the ramifications of valleys at different points of their course; fig. 5, those of confluences, as, for instance, those of the head waters of the Elbe, in the Bohemian basin, or of the Amazon; fig. 6, the middle and lower part of the valley, and is by no means a much caricatured representation of certain slate districts,* which have been little or not at

* Slate rocks have no exclusive claims to this: there is no reason why any well-stratified rock of equal consistence and equally horizontal beds should not give the same results.

all affected by igneous disturbances, such as at certain points of the Great Fish River Valley, near De Bruin's Post, and still more so half-way between it and Graham's Town, or in the tributary ravine of the Ecca in South Africa. This formality of shape is particularly conspicuous when the courses of the different streams either coincide with the dip and strike of the strata, or else directly cut through them at right angles. Certain portions of the Rhine (in the same rock) are equally rectangular, Fig. 7. and the Rhone is probably still more so. Fig. 7 is the Delta terminating figs. 5 and 6, but only on the alluvial deposits at the mouth, beginning from the point where the valley ends.

Valleys, however, are not simply composed of two slopes, A E, A F, (as shewn in section, fig. 8,) intersecting at the river A, but in general of several successive planes sloping down from the water-sheds (E E′, fig. 9), such as E D, D C, C B, B A, either meeting on both sides in A, or separated by a flat valley bottom, A A′.

Fig. 8.

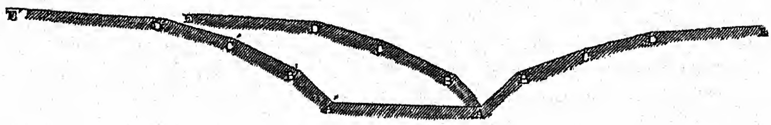
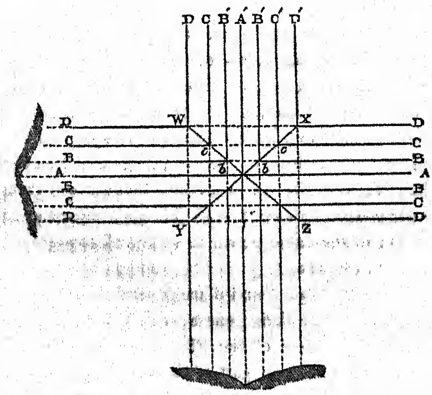


Fig. 9.

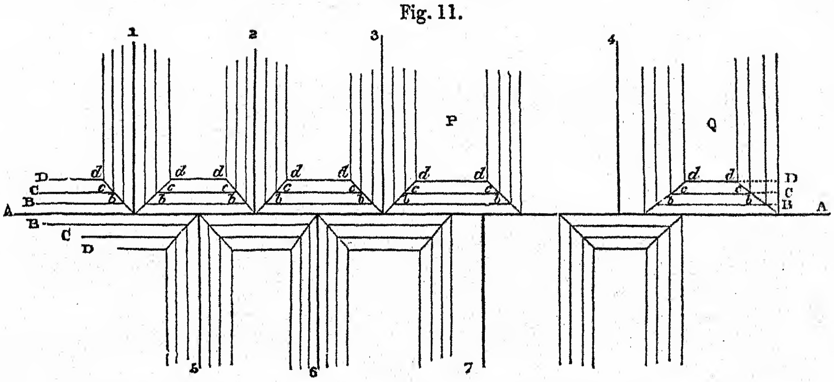
If two such valleys intersect one another, as in fig. 10, there will be a groin-shaped space (W X Y Z) formed; and it is of the greatest importance in sketching ground that the general form of the main valley be traced out by the significant correspondence pointed out by the dotted lines, between the truncated portions (D W — X D, C *c* — *c* C, B *b* — *b* B, &c.), and as if the general trench-shaped primary valley had never been invaded by the cross one.

Fig. 10.



Thus, in fig. 11, in representing the main valley A A, with its cross ravines, 1, 2, 3, &c., the original lines (D D) must still be indicated (or dotted out, as it were) by the fragments *d d* — *d d* — *d d*, &c.; C C, by *c c* — *c c* — *c c*, &c.

Fig. 11.



In Plate V. this principle is applied to a river (A) between the two water-sheds (W X, Y Z): the whole valley between these lines should be sketched with the feeling that the stripes or zones (across the mouths of ravines, Nos. 1, 2, 3) $e\,e$, $e'e'$, $e''e''$ — $d\,d$, $d'd'$, $d''d''$ — $c\,c$, $c'c'$, $c''c''$, &c., are still in existence. The same applies to the ravines themselves in reference to their own branches, as in ravine No. 4.

Attention to this is indispensable as a principal means of *representing ground as a whole*, in the manner adverted to in the earlier part of this article.

It should be remarked that where a river runs along a broad valley-flat, as on A A′, (fig. 9,) that it constantly changes its direction, as if repulsed, and rebounding from one side to the other, and at all sudden turns is to be found under the concave sides. On these last, the banks will be steepest, even to being perpendicular cliffs, as is particularly observable in rocks with tolerably horizontal strata, (*e. g.*) the Wye between Chepstow and Tintern (Plate IX.), or the Dove, in Dovedale, both in mountain limestone; or the Great Fish River, with its bluff 'kranzes,' in what often amounts to flint-slate. In Plate V. this alteration of steepness has been neglected for the sake of simplicity, and the section E A E′ (fig. 9) has been followed, rather than E′ A′, A E. This changing from side to side may likewise be observed on a good scale in mud-harbours and estuaries, such as Portsmouth, and the Hamoaze at Devonport; but more especially in their branches and creeks, in which, at low tide, this alternation of sides gives a good clue how to find the channel at high tides, even when guiding a party of boats in an expedition where one is a perfect stranger to the locality.

Water-sheds.

Referring to the last paragraph but one, and still in pursuance of the idea of representing ground as a whole, as far as it may be done without forcing and exaggerating what at times is scarcely perceptible, (as, for instance, in considerable tracts of the chalk districts, if taken at all in detail,) something must be said of the first order of master lines—the water-shed, or summit ridge—as equally important with the water-course, though not always so readily appreciable, very seldom appearing in the finished sketch, and therefore spoken of last, though almost the first to be indicated in pencil.

Plate II.

Although, for the sake of illustration, the ridge lines are given in the different accompanying diagrams, yet they are in dotted lines only, as they are never expressed in drawings, unless they should accidentally coincide with some otherwise minor feature line, as, for instance, at *b b*, Plate II., by a sharp ridge of rocks happening to run along the water-shed. Notice of them is, nevertheless, indispensable in original sketches, as fundamental memoranda, though they need then only be given, as above mentioned, in pencil.

In Class B, water-sheds, as shewn by dotted lines in Plate I. fig. 6, may be considered as always so co-ordinate with the water-courses that they may be almost invariably deduced from them,* and appended to the main ridges (W X, Y Z), as the streams are to the main river (A A).

Plate I. fig. 6. In Classes A and C, the subjects are too wild for any such formal connection. In the former, no particular representation is necessary, as the sand-hills vary in form and position with every wind, and it is therefore correct to express them conventionally, instead of specifically. In the latter class (C) the ridges are either those of forms of explosion, or else of lava torrents bursting out arbitrarily from any point in the sides of the volcanic cones; and far oftener so than from the main crater. In Classes E and F, as level surfaces, there is no appearance of this line, except, perhaps, where F, lying on, and thus forming part of, the high grounds, may happen to cross it. In Class D, as composed of B and C, there will be a combination of the principles of both; and, as before intimated, those of C (or their cognate effects, as forms of disruption amongst stratified masses,) will generally be prevalent in the upper, and those of B in the lower ground.

ORDER III.

THE COAST, OR HORIZONTAL CONTOUR LINE.

So far as the forms of ground have tolerably distinct outlines, as given either by a somewhat obvious ridge, or by the water lines, or by the boundaries of the various faces produced by the above-mentioned continual intersection of valleys, they may be given, as approximates to mathematical forms, in little more than clear outline, as far as the 'Field Sketch' is concerned; but it may also happen that the section of the ground may be too low, and its shape no longer defined by facets (as if in a measure polyhedral), but by curved surfaces, both in plan and section.

It is then that horizontal 'contour lines' are called in to assist in the representation.
Plate IV. They are such as would be given by successive risings of a flood to different levels: these will, in the first instance, start from the coast, though they soon lose all exact parallelism thereto, when the supposed waters, as they rise, find their way into valleys, and rise up the faces of the hills. It is evident that if ground be surveyed in this manner, and the heights of the different levels given, the plan of these contours presents the equivalent of a complete model of the ground.—See 'Contouring,' also the dotted lines of Plate II.

It is very desirable that the student should practise this operation to a considerable extent, as he will obtain thereby a knowledge of the true forms of ground which cannot be had in any other way; though the nearest approach to this will be given by the mud-bank model. When *on* a hill, the eye takes in so little at a time, that if not thus disciplined, a beginner is sure to give too great a roundness and circular formality to his forms. A like remark applies to sections, which are sure to be made too steep by the tyro, who, apt to estimate steepness by the fatigues of ascent, is generally much surprised at the low relief of ground with apparently considerable elevation and abruptness, on making his first section of the same. It is on this

* Exceptions to this rule are found in tabular deposits of gravel, which have in general no very perceptible water-shed, such as those already noted in the north of Germany, Bagshot Heath, Woolwich Common, and Blackheath at the foot of Shooters' Hill,—this last belonging to the *clay* portion of the London Clay Formation. The water-courses, however, are very distinct in these gravel plateaus, the sides of which are usually abrupt, and cut into numerous small hills,—such as those in Greenwich Park; the Repository and the 'Roughs' at Woolwich; the pleasure-grounds in the neighbourhood of Hamburg, on the banks of the Elbe,—or the banks of the Oder, at the Brüche, near Freienwalde.

account very desirable to study your ground at a distance, (for general correction as to relative importance of the different features,) as soon as the local details have been collected on the spot. The best times for this are a little after sunrise or a little before sunset.

These horizontal outlines (of horizontal sections) are strictly applicable to sketching, with regard to the shading touches being also horizontal, or nearly so. This style is very generally used at present, in preference to the vertical mode, which, however, is by some considered to have greater force in the expression of *very* steep ground, and is, perhaps, more easily understood in hasty sketches, where but little detail is admissible; though both styles become objectionable where they are made, unnecessarily, to supersede the simple outline for the main features, where this (the outline) would be clearer, and more rapidly executed than any quantity of shading.

As memoranda for subsequent study and completion, the best plan is to combine both, as shewn in Plate II.; but when everything must be made to speak as simply and quickly as possible, this would be a misplaced and not generally comprehensible refinement,—and the rough but significant hieroglyphics of Plate XI. are far preferable.

The relation of this Order III. to I. and II. is best seen by supposing, either on the mud-bank model, or on the actual face of the earth, what changes of topographical nomenclature are dependent on the supposed elevation or depression of the waters above or below the present level,—when the inland sea, the gulf, the bay, the lake, become the grand valley, or the mountain basin, convertibly.

Let the waters retire sufficiently, and the bed of the Mediterranean becomes the grand valley of a new river, issuing from between the Pillars of Hercules, as the conjoint result of the Nile, the Danube, Don, Dneister, and Po, besides numerous other new rivers of respectable magnitude. Let the waters rise, and Bohemia reverts to its probably former condition as a lake, of about the size of Lake Superior; the upper Alps become bold groups of islands; and the whole space now occupied by the Amazon and its branches resumes the character of an immense gulf, as large, perhaps, as both the Bay of Mexico and the Carib Sea together.—See Lyell's Geology, Plate II. (of 4th edition) shewing Europe as an archipelago at or about the commencement of the older Tertiary.

Thus the name and character of Order I., either as the Line of Shallowest Soundings, or as the Water-shed;—or of Order II., as the Channel of the Deep, or as the Water-course,—are terms depending entirely for their application on the level of the Third Order; and in the orthographic expression of ground, no one may decide on their relative importance. The First and Second are indefinite and unmeaning without the Third; and the Third is mechanical and spiritless without the First and Second.

The 'Contour' is particularly applicable to Classes E and F, especially the former; as peat formations are not exclusively, though very generally, confined to level, and especially lower grounds: abundance of water is indispensable to the plants of which they are composed; and as water is to be found on the side of a hill, as well as at the top or bottom, the peat-plant (generally Sphagnum Palustre in Britain and Ireland) will be found in any of these positions. In the Irish insular groups of hills, before mentioned, a very large proportion of the flat grounds thus representing water is filled with it, as the *sine quâ non* of the existence of these vegetable formations.

The masses of animal and vegetable* skeletons composing the coral formations are

* Corals are not exclusively produced by animals; they are extensively secreted by marine plants; and amongst the animals whose skeletons are thus accumulated, the Zoophyte (as is generally

necessarily (especially when incomplete) exclusively arranged in contours,—whether round nuclei of Classes A, B, C, or D, they conform to coast lines, or aggregate round the heads of sub-marine hills, in belts which cannot in any case rise above spring flood tides, and very generally—depending on the nature of the animal or plant—above those of the spring ebb. Whether these belts fill in subsequently or not, the external contour remains unaltered.

SUBORDINATE LINES,

such as *a, a, a, a,* in Plate II., occupy the same rank in the delineation of ground that the markings of the muscles, folds of flesh, &c., would in the representation of the body, after the main outlines, descriptive of the head, eyes, limbs, &c., have been given:—as thus subordinate, they are termed Minor Feature Lines. Where they refer to curved surfaces, they will be made somewhat to swell towards the centre, as would be done in the line that would express a cheek, a muscle, &c.: they will be more rigid as the forms become more angular. The study of Plate II. is particularly recommended to the student.

SECTION II.

PRELIMINARY ARRANGEMENTS FOR FIELD SKETCHING.

The whole district to be represented should be apportioned off to the assistants by the person who is responsible for the combination of the different parts.

The assistants should work together in the first instance at their common boundaries, to such extent as will insure agreement on the lines separating their respective portions.

To effect this agreement and general consistency, the skeleton diagram of the whole should be formed from the best and available authorities, giving the positions of the main points. If there be no trustworthy maps to supply these, they must be obtained trigonometrically, if the space exceed about 10 miles square, and the scale be greater than 2 inches to the mile.* It is in vain to expect accuracy, or even tolerable general coincidence amongst the parts, when every man works quite independently and without triangulation.

Each assistant should receive his sheet with those points *pricked off* from the general diagram that concern himself, and which will therefore include many of those surrounding, but not on, his own ground: of these he should make as much use as he can, so that as much as possible of the work may be relatively right, notwithstanding the moderate amount of absolute error which ought to be expected on this duty. The meridian should likewise be given from the general diagram.

INSTRUMENTS, &c.

Necessary to be prepared for Field Sketching with advantage.

The sheet should be *well* supplied with fixed points, as above.

Plate VIII. The meridians ruled as normal lines, either at fixed distances (see Plate VIII.), say 1 inch (or ½ mile) apart,—or else passing through the main points: both plans have their advantages.

The paper should be stretched so that the edges be secured from the wind; and

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assumed) is by no means the sole constructor: Serpula, and probably many others, contribute largely to these formations.

* A carefully chained base, and the skilful use of the pocket sextant, will provide for this space: if the points are not much more than two miles apart, it will not be necessary to compute the distances trigonometrically, but to lay these down by the protractor, constructionally, as in Plate VII.

there should be the means of covering it from the rain. Where, as in Section III., there is leisure and convenience, experience has shewn that a board, even of the size of a sheet of demy paper, (hinged in the middle, made of the thinnest and lightest wood that will bear the *framing* at the edges necessary to prevent warping, and supplied with a flapped Macintosh bag as a cover, fitted with a strap for slinging it over the shoulder,) amply repays the trivial inconvenience of carrying it, by the additional number of surrounding points that it can include. When, as in Section IV., this would be out of the question, the sketch-book, described in the note to Section IV., and tested by the long and arduous experience of Colonel Bainbrigge,* leaves nothing to be desired: with this last, portions only, such as single lines of road from point to point, and the ground immediately adjacent, are sketched at a time (see Plate XI.), and are combined on a general skeleton afterwards. The hinged board has the advantage of enabling one to complete everything on the spot, (a skilful sketcher need rarely go over the same ground twice, where there is no impediment to his movements,) and thus becomes a convenient substitute for the somewhat antiquated plane-table.

Plate XI.

The only instruments generally necessary in field sketching are a Schmalcalder's compass and a drawing scale; but in basaltic districts, or any other in which iron, in a form capable of affecting the needle,† abounds, instruments for taking included angles instead of bearings must be substituted, such as Colonel Bainbrigge's field goniometer, or the pocket sextant,—the former being by far the most satisfactory invention on the reflecting principle as yet invented. ‡

The most convenient drawing scale is the white metal, or even the common ivory protractor, $6'' \times 2''$; three edges occupied by degrees,§ the fourth cut to 40 to 1 inch, as a very useful scale for general use, being applicable to any multiple or sub-multiple of the mile (or 80 chains), especially when two inches to the mile is adopted, which is very commonly the case for the general sketch, of which parts can be enlarged subsequently for positions, lines, &c., as may be required. If preferred, this fourth edge can be cut to the paces per mile of the draughtsman: when this is not done, it will save much time, and possibly error, to have a small table of paces (peculiar to each person) as far as 20 chains, engraved on the scale. (See Plate VIII.)

Plate VIII.

The best material for sketching on is the Bank-post paper: when well made it is remarkably tough, and though thin enough for tracing through, yet it stands a great deal of severe work: by working at once on this, the *original document* is always preserved, which is not the case when asses' skin is used, and which entails loss of time, and the chance of error incident to copying.

The requisite colours, &c., will be Indian ink, sepia, Prussian blue, gamboge, and lake, for topographical purposes: when dispositions of troops are to appear, add cobalt, chrome yellow, and carmine, as being better suited, from their brilliancy, to catch the eye at once. The remaining items will be a small memorandum-book, brushes, pencils, the metallic pens ‖ now so much used, knife, and India-rubber. Many an

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* Now Major-General Bainbrigge, C.B., to whom we are indebted for the materials of Sect. IV.

† The carbonate of iron is not magnetic: hence the needle is used in surveying the iron mines of South Wales, where the ore contains the metal in that form.

‡ Reflecting instruments have the great disadvantage, when used for fixing one's position from given points, of requiring three of them, whereas the compass requires only two points, and needs no construction beyond that of laying down the bearings to obtain their intersection.

§ Troughton and Simms, Fleet Street, London, make a good strong scale for sketching ground, with lines perpendicular to the lower edge that go quite across the scale, and which are very convenient when the normal lines, as shewn in Plate VIII., are used.

‖ Those of zinc, as but little liable to rust, are perhaps the best.

inconvenient day's work, or vexatious walk back, will be saved by calling over the *muster-roll* of these things before starting.

SECTIONS III. AND IV.

INTRODUCTORY REMARKS.

In both of these Sections, the degree of detail in which the ground is to be shewn must depend on the purpose in hand; and in Section IV. on the time and opportunity afforded, to which in Section III. no limit is placed.

In Section III., without indulging in topographical niceties, a full account may be given of every feature of sufficient importance to be represented. In Section IV. nothing should be noticed that can be omitted; and the work in its rough way should speak as clearly and simply, as (with greater leisure for consideration) Section III. should clearly and amply. Thus, in Section III., and in the case of a chalk district, in which, from the absorptive nature of the soil, the streams are usually few and small, it might be proper to notice a rivulet which then and there might be topographically important, or which, for Engineer purposes, might be wanted to form an inundation; but it would be absurd to notice it in Section IV. when insufficient to stop even Infantry,—unless the ground were that of a camp, where the stream might be of consequence as a provision of water.

Plates XI. and XII.

In Section III. more or less of pen-work may be allowed, especially in representing the usual topographical hieroglyphics, as given in Plate VI., though the brush, with a little assistance, will work with far greater rapidity and equal force, with reference to hills, woods, marshes, &c.; and in general, for this Section, it may be said that the brush is in every way preferable to the pen or pencil when circumstances admit of its use, which is by no means always the case. Every use, however, should be made of the conventional signs of colour, especially in shewing water in blue, forests by flat shades of green, &c. No attempt should be made at expressing relief by light and shade in the field, though in skilful hands it may be advantageously used at home.

Plate VI.

What is wanted in Section IV. is something very simple and effective, that can be executed with sufficient accuracy and with the greatest despatch, and which may be immediately comprehensible by the General Officer for whom the sketch is made, under any circumstances of embarrassment and perplexity; and facility in doing this is *only* to be obtained by being familiarized with ground, as the result of previous study, practice, and attention to instructions, such perhaps as those given in Sections I. II. and III.

SECTION III.

The sketcher is presumed to be equipped as specified in Section II., and to understand the use of his instruments, and other drawing apparatus: it would lead to much unsuitable detail to attempt memoranda on these subjects.

Having carefully studied the ground in reference to the purpose in hand, and to the views given in Section I., proceed to detail and embody the ideas thus generally formed in the manner shewn in the following example,* in which it is assumed that no fixed points have been supplied (as pricked off from any general diagram), and have to be determined on the spot.

* The meridians have been omitted in Plates VII. IX. X. for the sake of clearness, but their use is shewn in Plate VIII.

Example 1, *Plate VII.*

Let A B C be the base, as obtained by pacing,—D, E, F, G, H, principal points fixed by intersections as they can be obtained, which in a regular survey would be obtained trigonometrically,—A 1, A 2, &c., &c., tangential bearings, which, by an early determination of the most important exterior points and lines, act as limits, preserving the work from distortion.

Suppose the object to be principally the peninsula;

Now as the heights running from D to F do not offer a suitable base, from the interruption of the fort and the irregularities of the hills, the ground A B C should be selected for this purpose.

Commencing at A, take bearings to the Martello tower (D), the flagstaff (E), and the south-west salient (J) of the fort. While on the spot, to avoid a useless recurrence to the same (and in military sketching you should never, if possible, *work twice* on the same ground), take the tangents A 1, A 2, A 3, A 4, which give limits in *one direction* to such parts of the contiguous coast, &c. as can be seen; and before leaving the station, sketch in as much of the ground as you can fairly judge, within a moderate distance all round; then pace on to B, noting such points as *a* (in the prolongation of the battery on the isthmus), or *b*, where you cross the road, &c., &c.; and this sort of observation should be CONSTANTLY made, as a general rule, inasmuch as you are then certain that the *relative* positions of the different objects are nearly right, although, in some instances, the *absolute* ones may be occasionally erroneous: it binds the work, as it were, together.

At B, *fix* D, J, and E, by intersecting the bearings taken at A; take other principal bearings to the point C, the tower F; also the tangent B 1, which not only gives a *limit* to the rocks at *d*, but one to the coast at *e*. Proceed as before to C, remarking that at *f* the towers F and G are in a line with yourself.*

At C, *fix* the tower F, by intersecting the bearing from B; and the point *e* by C 1, cutting B 1.

Having thus secured all the ground along which the base runs, on the north side of the gulf, return to the point *b* (where the base between A and B had crossed the road), and pace to, and lay down the works on the neck, sketching the ground to the right and left as you proceed.

As D has been already fixed, you need not *pace* up to it after marking down the redoubt and long battery on the isthmus; but on arriving at the said point (D) take bearings to H, and the tower G; also the tangents† D 1, D 2, D 3. In order to lay down the south front of the fort, pace a line (D *g*) as near it as the marsh *h* will allow: the remainder of the work can be completed from station E.

E. After thus finishing the fort, *fix* the towers H and G by intersecting bearings (E H and E G), and then prove the accuracy of the situation of F by E F. As the situation of B is more certain than that of C (since any accumulation of error from inaccurate pacing must of course be less on a short distance, A B, than on a longer one, A B C), E is a *senior* point to F (which was observed from C); therefore whatever position is given to this last from E, it must necessarily take precedence of that from C, and correction is to be made accordingly. For a like reason, if on arrival at C, you

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* Work may often be checked and verified without a single measurement being taken, by thus availing oneself of such coincidences and alignments.

† No opportunity should be missed of securing the general directions of the principal summits, crests, and slopes of hills by these tangential bearings, the continued intersection of which gives much assistance in not only fixing the position of hills but also their true forms.

found that the bearing C E passed east, or west of E, then shorten or lengthen B C, until the aforesaid bearing intersects exactly.

Next, place yourself outside the fort, as near as possible to E, judging the distance; and having laid it down, go towards F: this distance (E F) pace, not from being uncertain of the place of F, but in order to ascertain that of the neck lying between it and the fort.

Arrived at F, sketch the surrounding peninsula as nearly as may be judged, but not giving yourself much concern about it;—partly because the north side is already well defined by the tangents (B 1, E 1); and partly because you will see, that in going to the southern side of the main hill, and reaching the tower G, you will have abundant opportunities of laying down the south side of the peninsula (F) by such tangents as G 1, *k* 1, E 3.

Then return to D, and pace towards G, so as to obtain proper points (*i* and *k*) on the line D G: from these last (*i*, *k*) good intersections may be obtained (*i. e.* such as vary between 45° and 100° at the point where the bearings intersect) for fixing the point and houses (*m*); and from whence also tangents may be obtained to the shores of H *n* and *o*, by *i* 1, *i* 2, *i* 3,—*k* 1, *k* 2, *k* 3.

In like manner proceed for any other points; and a very limited share of practice will give ample experience as to sketching the intermediate ground with sufficient fidelity for ordinary military purposes. If, however, there should be any doubt as to the accuracy of any particular part, as at G 4, take a bearing in that direction from G, and pace on it to the point in question.

Memoranda.—The heights of the hills should, generally speaking, be given (usually in red) on the summits; and any conventional signs employed should be *invariably* explained in the margin;—such as those given in Section IV. to denote the different degrees of passability for the several descriptions of troops, &c.

In plans of camps and battle-fields, the top of the plan is always towards the enemy.

Houses of masonry in red; of wood in Indian ink.

Example 2.

Plate VIII. This was sketched in reference to a project of defence once made for the ground opposite Quebec. As affording also a good field of action, it was accompanied by Plate IX. (Plate IX.), as an *Abstract of Facilities and Impediments*, independent of the hill-work: in the original, the spaces now shaded were flat washes of green, to shew the woods. From a sketch like Plate VIII. a much more detailed plan can be made than would be necessary for any battle-field, where much of what is now given would be improper, especially as from the fragmentary character of this drawing there was no scope (or occasion as it happened) for further completion of the form of ground: as it now stands, it is only fit for a memorandum to enable the draughtsman to complete a finished and enlarged copy.

Plate VIII. The topographical character of this ground is as given in Plate I. fig. 3 (A and C), and at P 4 Q, fig. 11, wherein a sort of hammer-headed peninsular hill (A) comes to the St. Lawrence with a flat valley bottom (B) between it and the next and like hill (C). These hills (A, C) are the last features of individual members of a series of offshoots from the water-shed separating the waters of the St. John from those of the St. Lawrence.

In sketching this ground, the road from Point Levi to Chaudière gave an excellent main base, not only for the ground between A and the river, but also for fixing the opposite or Quebec bank. The road D E F G, as a cross base, gave checks on many

observations taken from the main base: it also afforded numerous points not to be seen from this last, and determined to a great extent the true position of the back road leading from Beaumont and Beau Sejour to N'importe.

Example 3, *Plate X.*

Plate X. In this, which is given as one of the most difficult cases, the road at the bottom of the deep and narrow valley (A, B) cannot be seen from the grounds above: the upper parts of this valley are so loaded with copse and young trees as to present not a single point for connecting them with the lower parts: hence the whole distance (A, B) had to be laid down by laboriously protracting the different lengths of the road as they successively presented themselves. This is a common occurrence in wild countries well covered with woods, and where the only roads lie where they cannot by any possibility be connected with the trigonometrical points. Protracting the line patiently as above is the only resource in this case. In Plate X. there is a quantity of detail in the direction and turnings of the road, which would be unnecessary for almost any military purpose,—though in this case it was unavoidable. The feature lines of all the ground, except the Gaer Hill, are remarkably sharp in many places, as is very common in the English mountain-limestone districts, in one of which the subject of this plan is situated.

In laying down this ground, the paced base lay between the Wyndcliff and a tree on Panter-Rede: from these, and the two intermediate points shewn on the diagram, every good object that could be seen was fixed,—such as Black-wood Cliff, Piercefield Cliff, and half-a-dozen remarkable trees,—all of which were visited for check and verification, as well as to obtain tangential bearings for the river, woods, hills, &c. There was no difficulty in thus managing the plateau; but the road and ravine from A to B could not be seen from it as soon as the Raven's Nest was passed. More assistance was obtained from the Wyndcliff and Black-wood Cliff, as regarded the road from St. Arvan's to Tintern, and the river,—but even here much had to be done by the tedious process of protraction, assuming that the left bank was inaccessible.

SECTION IV.

FIELD SKETCHING BEFORE THE ENEMY.*

It is of the first importance that sketches of ground required to aid in arranging the movements or positions of an army in the field should be made with the utmost rapidity: if not finished quickly, all the labour expended upon them is useless; therefore time should not be lost in making detailed drawings, as a rough sketch, if clear, is all that is necessary for this purpose.

To make the plan of a position, several Officers may be employed at the same time, so as to complete it within a few hours: if a tolerably correct map of the country can be procured, one Officer may be employed in laying down on paper the principal points, whilst the others are making the sketches on about the same scale, which he can afterwards put together. The scale of 4 inches to the mile will generally be found the most convenient for this purpose.

Each Officer on coming to the ground should commence *at once* by laying down upon his paper the bearings of the most remarkable points visible from his station (which may generally be done sufficiently accurately † without instruments, and even

* From Memoranda by Major-General Bainbrigge, C. B.

† Only by those who have previously been well instructed and have had considerable practice. —*Ed.*

without dismounting), and at the same time the ground adjacent may be sketched in: the same must be done at his next station, the intersections of remarkable objects being always noted, and the whole operation carried on upon the same *principles* as those detailed in Section III.

It is not necessary to measure a base until in the course of the work a convenient place is found, as the bearings of the objects will sufficiently determine their *relative* positions; but a base might be paced by an intelligent Orderly to save time, and the best way to do this is to count only the alternate paces, or by double paces.

Where there is no accurate map available, the angles between the principal points may be measured by a pocket sextant, or by a compass. The covers of these instruments should always be attached to them by hinges, so as to serve as handles to them when in use.

The best touch for representing ground in the field is perhaps that of the vertical stroke, as the roads are thus better distinguished: the description of wood, marsh, &c., should be marked in writing.

The ground impassable for troops may be distinguished by the sign . . . .

That impassable for any but infantry . . . .

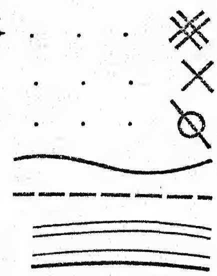
That passable for all but carriages . . . .

Foot-paths may be drawn thus . . . . .

Horse-paths thus . . . .

Common car roads . . . .

Great high roads . . . .



The meridian line should also be drawn quite across the sketch: see those in Plate VIII.

All ground within cannon-shot (1200 yards) of the position on the flanks and front should be shewn, and the distances to the nearest towns should be marked on the roads.

The prominent points of ground must be numbered (if possible in red) in succession, to shew their relative commands, marking their approximate heights above the water or plain, or merely numbering them 1, 2, 3, 4, supposing differences of level of 30 to 50 feet (which must be specified in the margin) between them: all points where the horizon would cut as it appears from any station may be considered to be on the same level as it, and the proportionate heights of trees, houses, and animals, will aid in determining these levels.

It is through Major-General Bainbridge's kindness that the writer of Sections I. II. III. is enabled to conclude this article by two specimens of Field Sketches, as actually executed by the above-mentioned Officer during the Peninsular war.

Plate XI. is the facsimile of part of a day's work *along a line*, in the neighbourhood of Tariego.

Plate XII. and the following memoranda afford a complete illustration of the first paragraph of Section IV.; their interest is enhanced by their giving an account of how the sketch was made on which the Duke of Wellington took up his first position on the day before the battle of Salamanca, on the 21st July, 1812.

Memoranda to accompany Plate XII.

"Dublin, 5th January, 1846.

"Having been requested by the Editors of the 'Aide-Mémoire' to give a specimen of the sort of sketch of a position required during the Peninsular War, with an account of the mode of performing the work; the annexed, which I was required to make by his Grace the Duke of Wellington in Spain, is supplied accordingly; and the following is a statement of the circumstances under which that sketch was ordered, and the way I took to perform it.

"In 1812, when the French army, under Marshal Marmont, was crossing the Tormes, at Huerta, above Salamanca, before the forts of that place were taken, the Duke—at that time standing on the high ground in front of Cabrerizos, observing the enemy—desired me to cross the river, and see what sort of a position there was in a certain assigned direction, for stopping the advance of the French, and to make a sketch of it as quickly as possible.

"There were about two miles to ride to the ford of Sta. Martha, and perceiving at once that that point would be the left of the position, on having crossed, I began at the point A.

A. "The lines of direction to B, C, D, E, F, G, were first laid down, sketching in the river, the roads, the village, and particularly the church of Sta. Martha. These lines of direction were, in fact, so many angles laid down and protracted on the sketch, but no instrument was used, as there was no time: everything was done by the eye. I did not dismount, and galloped from station to station.

C. "Having finished at A, I went along the road to Huerta (C), a farm of only two or three buildings, which was the only point to be seen in that direction from A; judging, then, this distance galloped over, the line from the church of Sta. Martha to C was assumed as the base.

"It was desirable that this front of the sketch towards Huerta should be done first, as the enemy's skirmishers were exchanging shots with ours between C and Pelobravo (M), when I reached that ground.

"C being fixed, the lines to H, I, J, K, L, M, were laid off; the line H intersecting the line B, shewed where the rivulet joined the Tormes. The line J, intersecting A E, shewed nearly where the steep fall of ground at J would come. The line L pointed out where the road to Calvarosa Abaxo crossed the rivulet, and to that point (N) I went.

N. "Here the angle between Sta. Martha and C was laid off, which fixed N, and then intersecting the lines I and K (taken from C), those two farms were fixed. The direction (O) of the stream was noted, and also the line to J was intersected: also a fresh object (P), a remarkable tree, was taken, as it was the only object between J and P, along the crest of what would obviously be the position.

Q. "The village (M) could not be seen; I therefore went to the rising ground (Q) from whence it was visible: at this point it was observable that I was in a line with the farm (K) and Sta. Martha church; then, assuming that line to be correct, the angle between Sta. Martha and C was laid down, which thus fixed Q. The next angle was that between C and M, by which the village M was fixed.

P. "Proceeding from Q, up the hill, to P, the angle was taken formed by N and Sta. Martha, which fixed P; it was also noticed that the line to the farm (I) passed to the right of the farm (K), which observation helped to correct the

sketch: also it could be seen that the line to H passed over K. The direction (J) was next taken, shewing the fall of ground and the direction of the road (D). There were no other points that could be fixed between D and the skirt of the wood (R).

R. "I then galloped to the top of the hill, and placing myself in a line with the two farms (I and K), that line was assumed to be correct; and then observing the angles between K and Sta. Martha, between K and C, and K and P, R was fixed.

"At R, I could see (over the trees) the village of Calvarosa Ariba, and also a chapel (called an Hermita) on this side of it, the directions to which were taken; also to the remarkable hill (S), and the abrupt slopes of the ground to the rear (U and V).

"A line was drawn to the fall, or gap, in the ground (T), taking great care that this, as well as those to S, Calvarosa, and the chapel, were as correct as possible in regard to the line from P, because the connection of the right of the position rested on this point, and the accuracy of the winding up of the sketch would depend on the correctness with which those angles were taken.

T. "Next to T; and as, on reaching it, it was clear that none of the points on the left of the position could be seen, except R, it became necessary that the distance from R to T should be judged as accurately as possible—which distance became a fresh base. At T, thus fixed, all the right could be seen, and the Hermita could be intersected, as well as the ground to the rear (U, V, and E). The direction (X) of the smaller hill was taken, and the line over its summit, it was observed, passed to the abrupt right-hand slope of the ground (W), to the rear of the position. A farm also, in a hollow of some wood to the front, was also noted.

X. "I then went to the smaller hill, intending to go to the top, but the rocks were so rugged I could not ride up; so, standing on a line between it and T, at X, that station was fixed by observing the direction to E and to the Hermita.

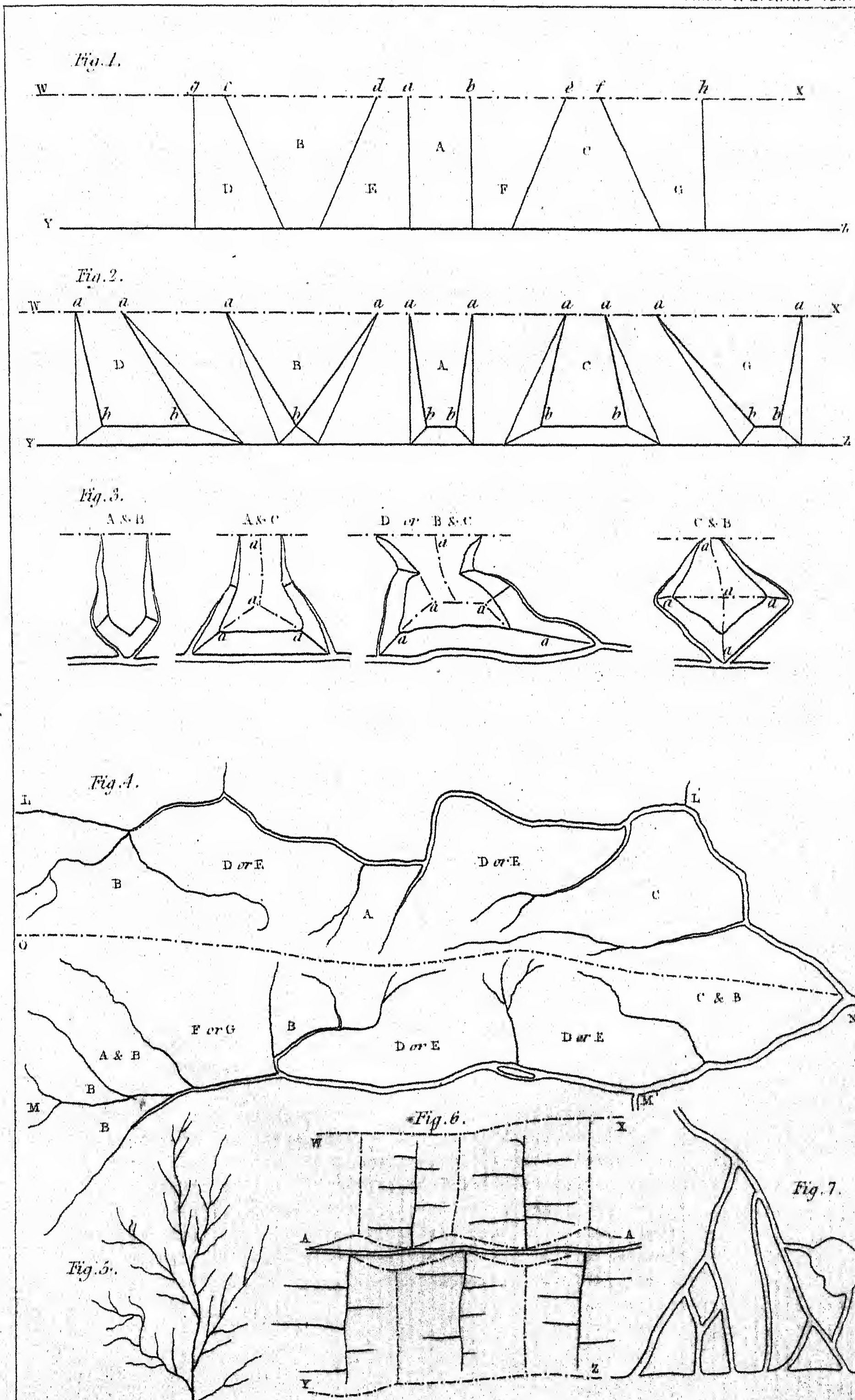
"The line to Calvarosa from R was next intersected, which fixed that place. The direction to the houses (Z) was also laid down, and this place turned out to be the village of Arapiles; and the two remarkable hills were the celebrated hills of the same name.

"The line W being intersected, gave the boundary of the ground (Y): the farm in front, observed from T, could no longer be seen.

"Passing, then, down by the right and along the hollow between the two great hills, I went to the Hermita, and this point having been before fixed, from thence the direction of the further fall of the great hill (S) and two slopes of the hill on the further side of the Calvarosa valley were secured, as well as the direction of the water-course above and below. I then passed down the valley, and wound up the sketch at O.

"Going back from thence to C, I proceeded along the main road to D and E, putting in, on judgment, the village of Carvajosa, as well as the point F, where was a house, and where the great Salamanca road passed.

"I returned to Cabrerizos, finding the Duke where I had left him, and handed him the sketch, having been absent about two hours and a half. I made a verbal report to his Grace, pointing out the high hill (S), which we could plainly see from the spot where we then stood, observing that it was doubtful whether guns could be brought there, not having had time to ride thither.



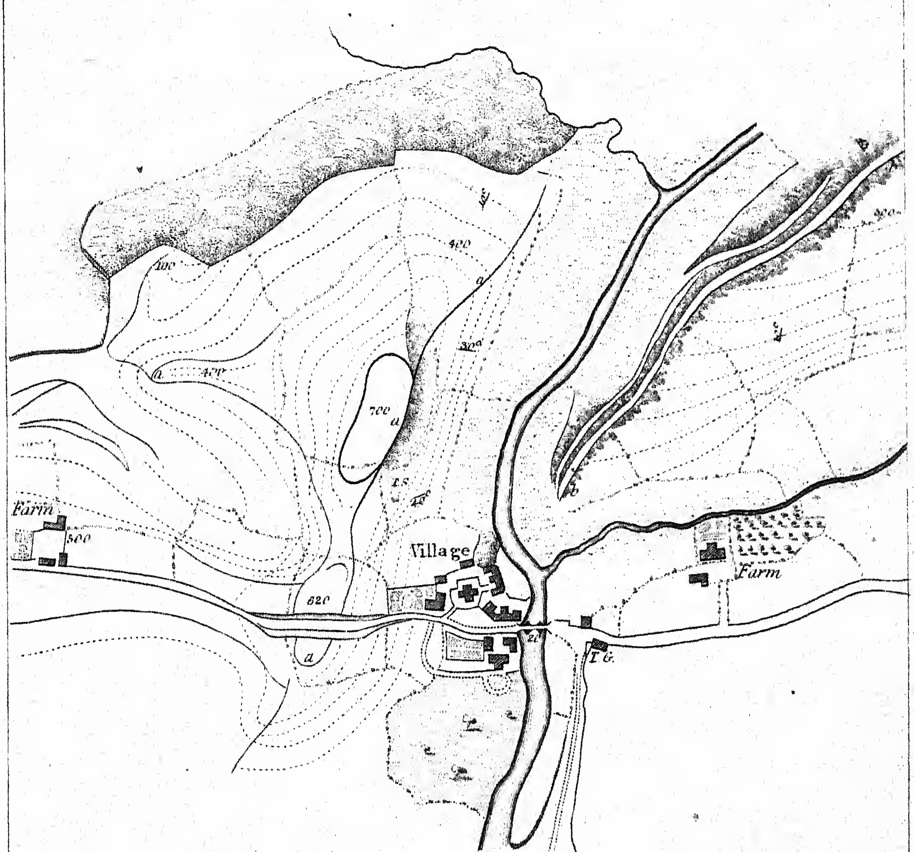
R. J. N. del.

J. W. Lowry sc.

John Weale 59 High Holborn 1846.

OUTLINE EXPRESSION

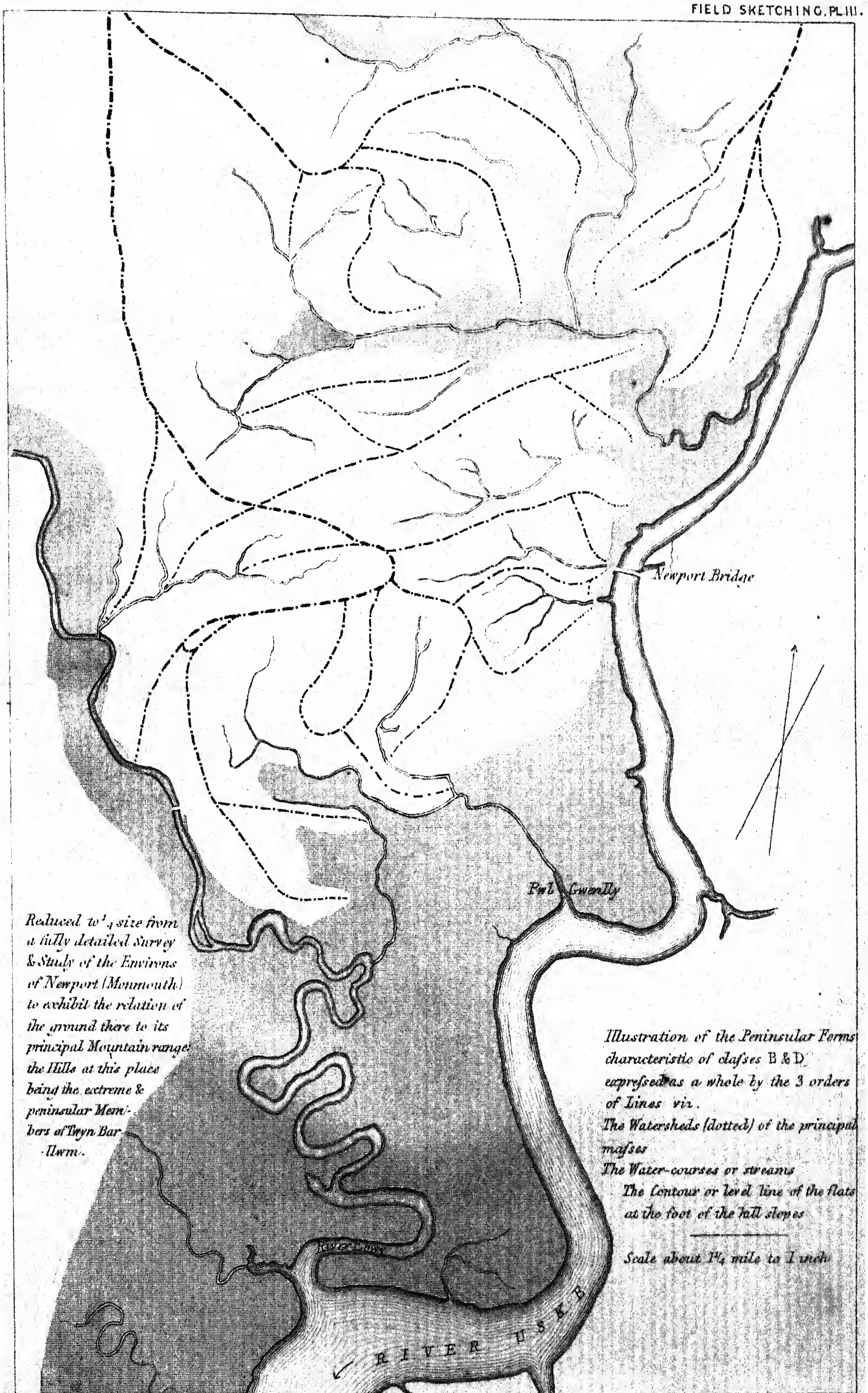
BY MEANS OF CONTOURS AND FEATURE LINES ONLY,
FROM A STUDY OF GROUND BY M[r] DAWSON,
1825.



The Numbers 700. 500 &c. shew the heights of the hills above some assumed point.
The inclination of the slopes to the horizon are shewn by 10° 30° &c.

R.I.N. del[t] J.W. Lowry, fc.

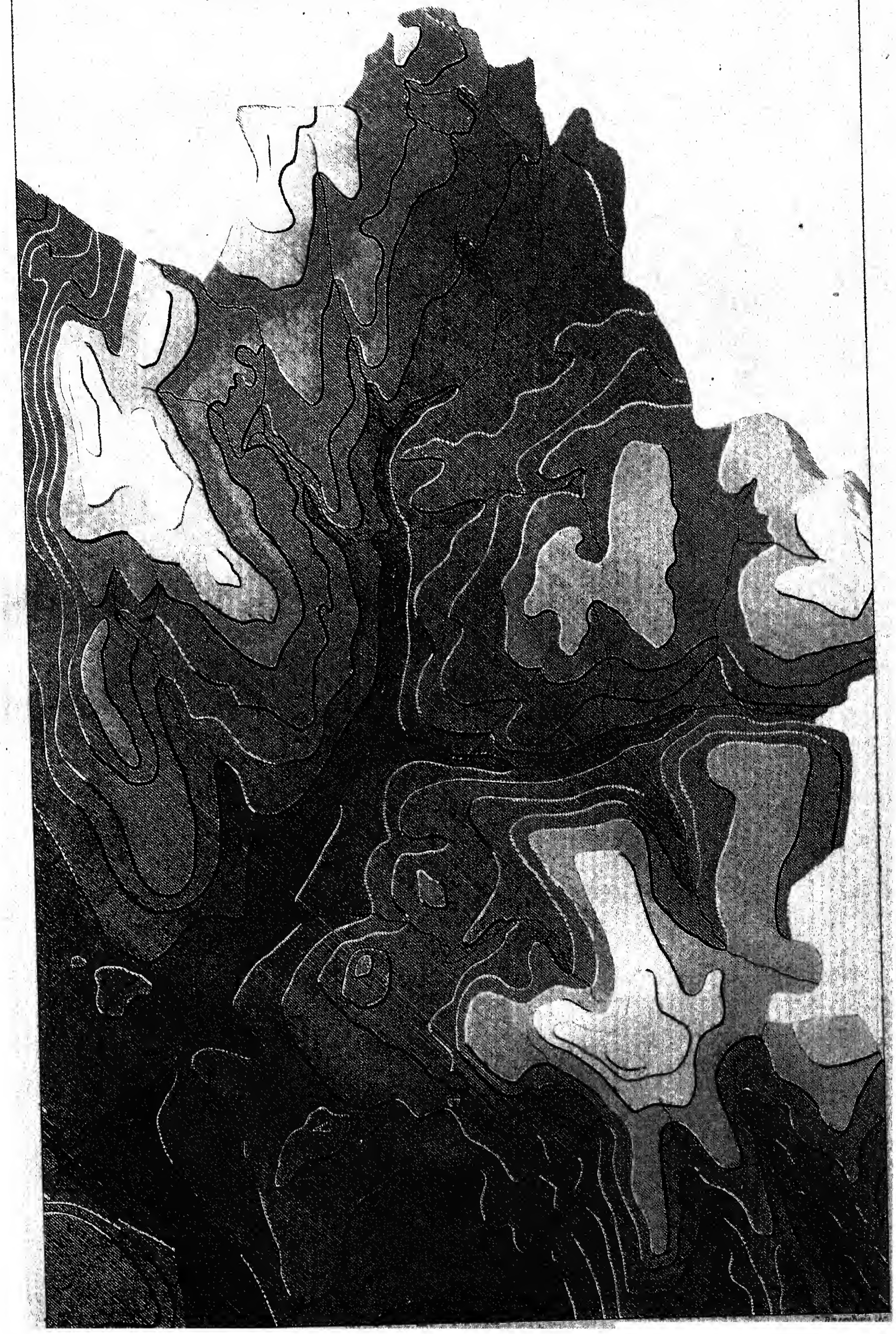
John Weale, 59, High Holborn, 1846.



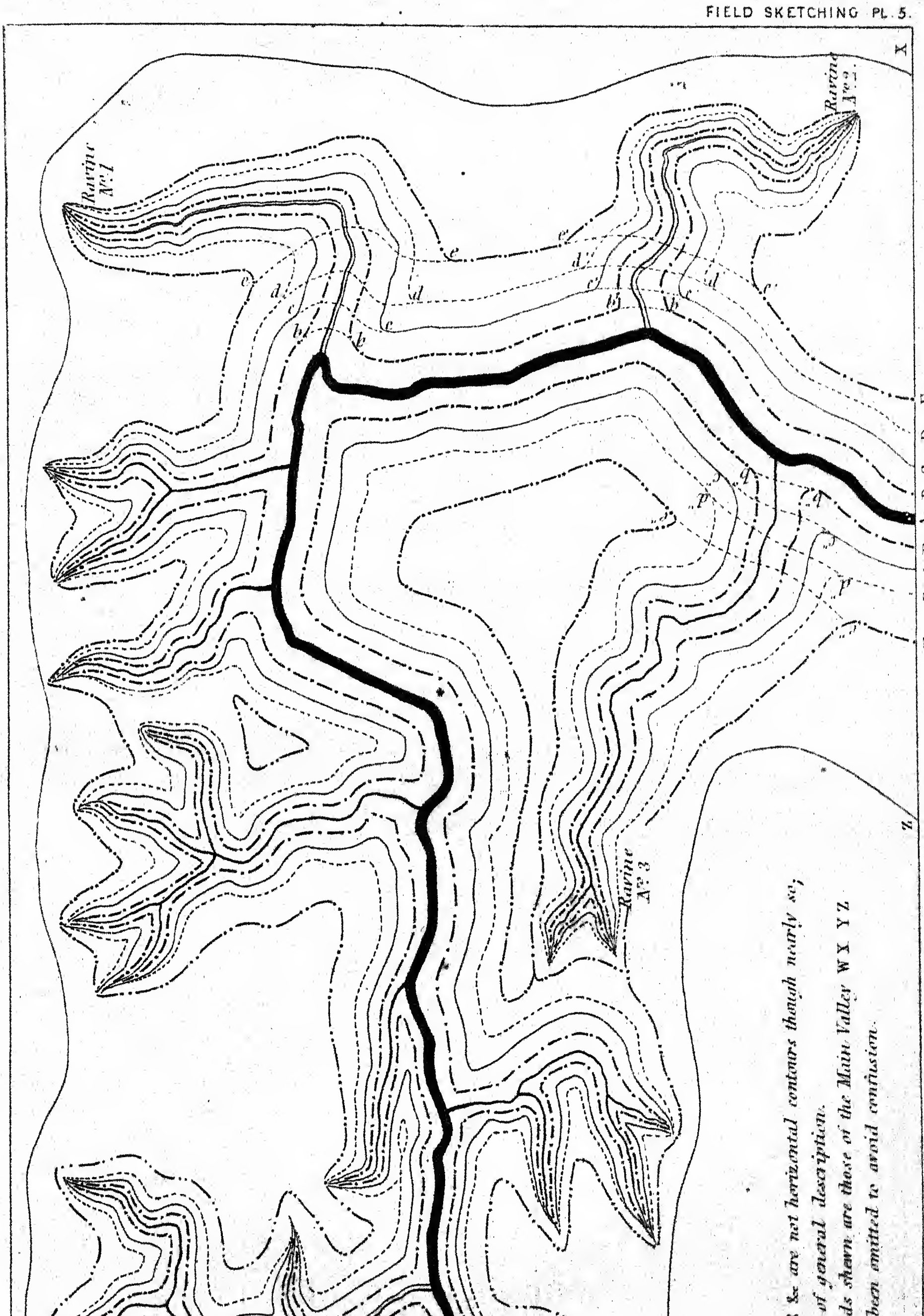
R.J.M. del. J.W. Lowry fc.

John Weale 59 High Holborn 1846.

Specimen of Contoured Ground in the County of Kilkenny.



John. Weale. 59. High Holborn. 1846.



R.J.N. del. J.W. Lowry sc.

John Weale 59 High Holborn 1846.

Tramways

... Roads. The ... from the light ...

... Roads, narrower, and both sides ...

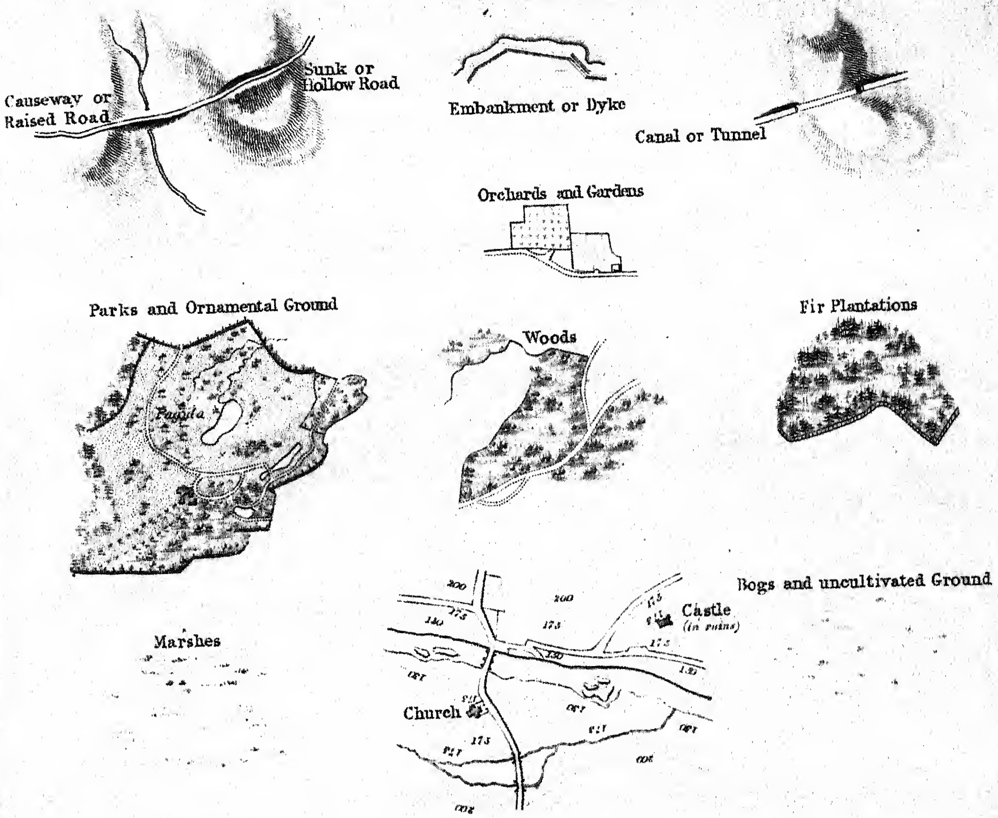
Main Roads, both sides ... and perfectly parallel

Canals, lighting ... Roads ... of the ... the Locks and Bridges, and by leaving the side next the light shaded like Rivers. Canals and navigable ... to be coloured Blue.

Stone Windmills

TOPOGRAPHICAL HIEROGLYPHICS.

ADOPTED ON THE ORDNANCE SURVEY.



Bleaching Grounds. Thin lines of the same length, nearly Parallel the whole colored Green.

Linen Manufactories.

Smithies. A small Horse Shoe with the open side turned towards the Road.

Limekilns.

Iron Works.

Glass Works.

Tanneries

Turnpike Roads. The side from the light shaded.

Cross Roads. narrower and both sides alike.

Rail Roads. both sides dark and perfectly parallel.

Canals. Distinguished from Roads by the parallelism of the sides the Locks and Bridges and by having the side next the light shaded like Rivers. Canals and navigable Rivers to be colored Blue.

Stone Windmills.

Bridges.

Ford.

Ferry.

Fish Weir.

Mines:

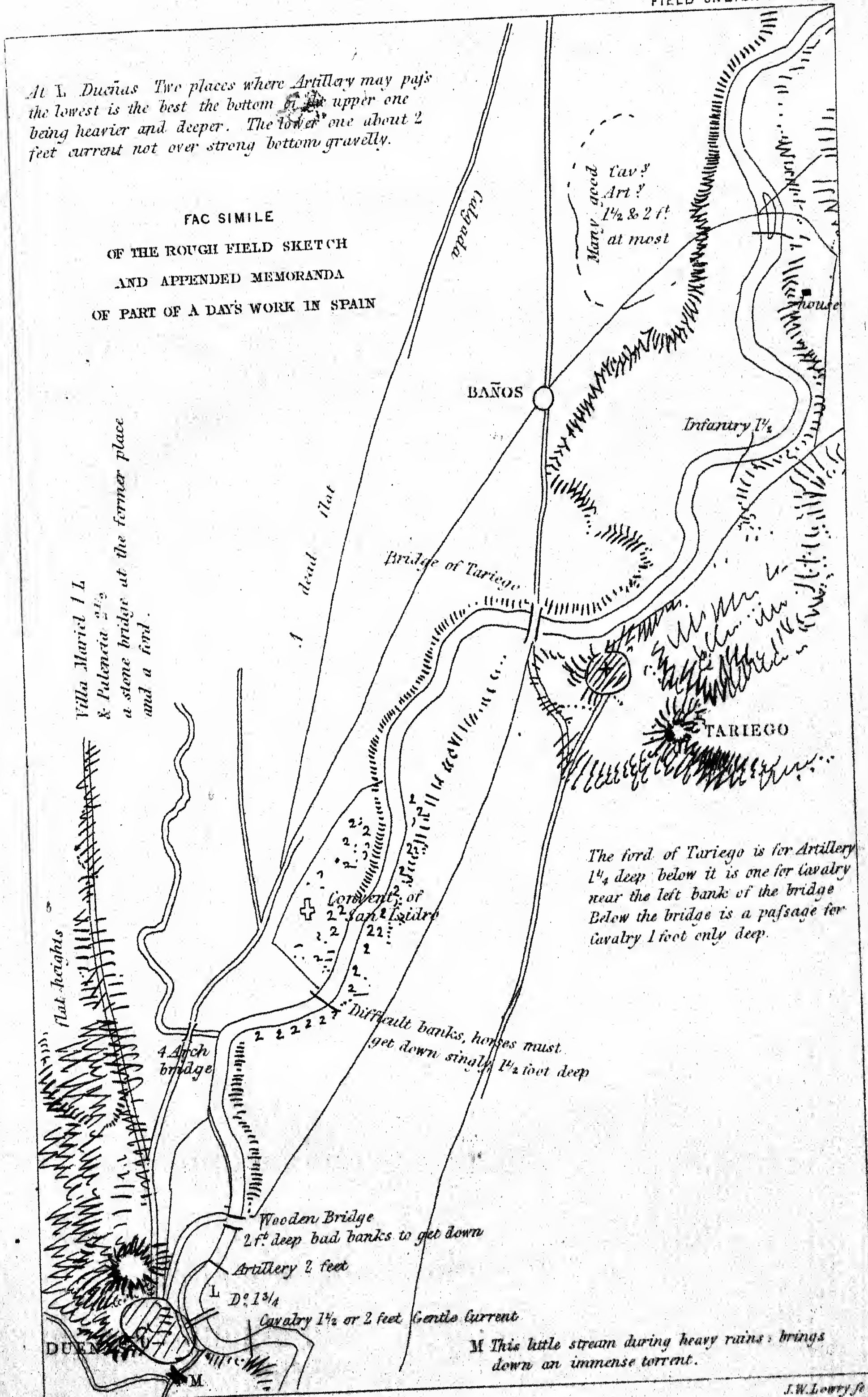
- ☿ Mercury.
- ♀ Copper.
- ♄ Lead.
- ☽ Silver.
- ☉ Gold.
- ♂ Iron.
- ♃ Tin.
- ⊖ Coal.

Chapels.

Public House.

Posting House.

Trigonometrical Point



J.W. Lowry fc

John Weale 59 High Holborn 1846.

The Duke gave me back the sketch, to put it in ink, which I did, sitting down on the ground, and I returned it to his Grace.

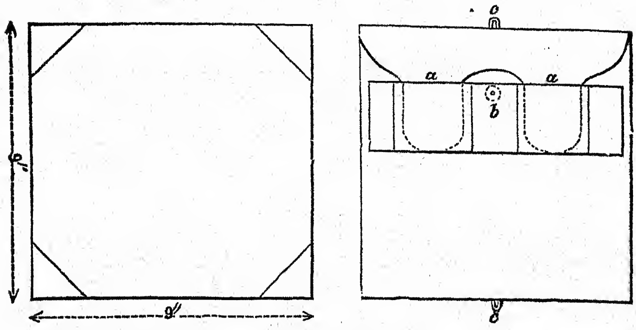
"In the afternoon of that day the position just sketched was occupied by part of our army; and the enemy having, by signal, communicated with the forts of Salamanca, re-crossed the Tormes at Huerta, and retired on the Douro.

"Some weeks after (July 21, 1812), this position was again occupied, but being too strong to be attacked in front, the French marched round it, and the battle of Salamanca took place next day, to the right of the ground here sketched—viz. to the right of the village (z) of Arapiles. In making this, I used a sketch-book like that described in the note below.—P. B."

R. J. N.

Portfolio Sketch-book recommended by Major-General Bainbrigge.

Back. Front.



It is made of light paste-board, covered with dark-coloured *parchment*, and has two tongues (*a*, *a*) to the flap which closes it, thus leaving a space for a large flat button (*b*), which will act as a swivel, a cord or strap being attached to it so as to suspend the sketch-book round the neck, and thus admitting of its being *turned round on the hand* during the progress of the sketch, to correspond with the direction of the points to be laid down: there may be a loop (*c*, *c*) at each of the sides, as they have been found useful for suspending one side to a front button of the coat, and thus supporting the book in a horizontal position (the opposite side resting on the strap which goes round the neck), whereby *both* hands are free to rule lines or set off angles on the sketch: it may also be advantageous to have an extra flap or an outer case to protect the sketch whilst moving from one point to another.

Sockets for pens and pencils are placed at the sides and along the top, within.

N. B. If larger than the above, it cannot be well concealed under the great coat, which is often indispensable.

FIRE, VERTICAL—

A received, but indefinite expression, for practice with shot, shells, or stones, as fired from howitzers or mortars, though more generally from the latter.

For ranges and charges with these pieces, and their application at Sieges, see 'Artillery' Tables E. F.; 'Attack,' pp. 94-97, and 'Breach.'

With reference, however, to the more restricted sense adopted by Carnot in his 'Defence of Places,' it implies the discharge of numerous small iron balls (weighing from 1 lb. to 4 oz.) from mortars at an elevation of about 75°, to impede the progress of the attacks during the near defence.

It is more than likely that in the style of 'special pleading' in which Carnot wrote for particular purposes, he over-rated the merits of this arrangement; but in disproving his assertions, there is considerable reason to suppose that justice has not been done. Experiments were made at Woolwich towards the close of the war, in which the balls were received on sheets of wadmilltilt, which, from its toughness and elasticity, could have given no true indication of the real effect, although the opinions based on these necessarily deceptive results were for the time considered as decisive on the merits of Carnot's position.

The following experiments were made by the Bengal Artillery:* if such were the results at 45° elevation, we can form some estimate of what would have been given at 75°, with a suitable increase to the charge.

Mortars.	Elevation.	Charge. lbs. oz.	Number and Weight of balls.	Range. yards.	No. of Rounds.	Results.
13-inch.	45°	1 4	441—8-oz.	160–170	2	"Ranged compactly, none falling by the way."
Do.	Do.	1 6	900—4-oz.	Do.	1	"Fell in a pelting shower, rather beyond 170 yds."
Do.	Do.	1 8	900—4-oz.	Do.	1	Covered a space of 50 yds. long and 20 feet wide, "along the space that would have been occupied by an assaulting column."—"The whole space was paved with shot."
10-inch.	Do.	0 12	240—8-oz.			No further details given as to results, but they are stated to be of "like effect" with the above. "The balls appeared in the air like a flight of small birds, so close that the light could scarcely be discerned through the mass."
Do.	Do.	0 13	532—4-oz.			
8-inch.	Do.	0 6	114—8-oz.			
Do.	Do.	0 6½	228—4-oz.			

N. B. The balls were in canisters, and on a wooden bottom 3½ inches thick.

In addition to these, also, the writer of this article was present at some experiments in which only a Coehorn mortar was used; the elevation 75°; charge varying from 3 oz. to 4 oz.; thirty-six 4-oz. balls each round; range about 100 yards; and the object fired at was a space of 18′ × 18′, covered by four deal targets laid on the ground. The balls scattered so as seldom to hit the targets: of the few that struck, the penetration into the wood was from ⅛ to ¼ of an inch, *far* exceeding the utmost efforts of the strongest man of the party present, when flinging down the balls upon the target on which he stood, though he sent one through a felt cap.

The mere scientific opponents of Carnot argue that no ball falling vertically can acquire a greater than the 'terminal velocity,' which is about 250 feet per second for a 1-lb. ball, and about 460 feet per second for a 42-lb. shot. Now the velocity acquired by the 4-oz. balls from the Coehorn could scarcely have exceeded 100 feet per second, yet no man could have stood its discharge for a moment. Referring to the 1-lb. balls as proposed by Carnot, and their terminal velocity of 250 feet,—at 300 feet per second the elm block of the ballistic pendulum just refuses admittance to an iron ball; but where is the head that would do so? The wounds and bruises received will be those of the very disabling and distressing character of a spent shot. It is submitted that this question merits reconsideration. R. J. N.

* Communicated by Lieut.-Colonel Sandham, R. E.

FIRE, PRECAUTIONS AGAINST.

Our total failure in destroying the shipping at Antwerp in 1813–14 must be, in part, attributed to the measures taken by Carnot, who was then Governor. From such information as can be obtained, it would appear that they chiefly consisted in the establishment of well-organized fire-parties; and in securing the ships, by covering the decks with earth and dung, and supporting them by numerous props and stanchions.

What is given by Carnot, par. 47, 4th head of 'Defence of Fortresses,' may be combined with the following from Laisné. 2nd ed. p. 403.

" Lorsque la place est petite, ou si toutes les troupes ne peuvent être logées dans les quartiers où elles soient en sûreté contre les projectiles de l'assiégeant, on *blinde*, autant que possible, les casernes les plus rapprochées du front d'attaque.

" Il convient surtout d'affecter à l'usage d'hôpitaux, les souterrains les plus sains et les meilleurs bâtimens à l'épreuve soit voûtés, soit blindés au moment du besoin.

" Les fours, les puits et les citernes doivent également être garantis contre les bombes, par des blindages, s'ils ne se trouvent disposés dans les locaux voûtés à l'épreuve.

" Pour diminuer les effets de la chute et de l'explosion des projectiles, on peut, dépaver les cours et une partie des abords de tous les établissements militaires.

" L'un des plus grands dangers dans une place assiégée étant celui des incendies, on devra organiser des compagnies des *Pompiers-bourgeois;* former des réservoirs d'eau multipliés, avoir 20 grandes échelles de 10^{m}. de longueur; 40 échelles moyennes de 7^{m}.; 50 petites échelles de 4^{m}.; 40 crocs ferrés gros et longs emmanchés; 10 pompes à bras; 350 seaux de cuir.

" On placera sur les clochers les plus élevés des *guetteurs* qui au moyen de cloches et de porte-voix, averteront du feu et des endroit où il éclatera. Ces guetteurs pourront en même temps, pendant la jour, observer les mouvements de l'ennemi, et en prévenir le gouverneur; pour cela, ils descendront leur avis écrits," &c.

Napoleon's decree, 24th December, 1811, article 94, relative to the defence of places, was, " Le Service d'Incendie, en cas de siége, ou de bombardement, est reglée par le Gouverneur ou Commandant, de concert avec le Commandant de Génie et l'autorité civile."

It is to be observed that when a dockyard, in which there are several ships either in dock or on the stocks, tolerably near one another, is once thoroughly on fire, no hitherto arrangements in the way of ordinary fire-engines are of the *slightest* use. Dockyards should be provided with reservoirs with the requisite *steam power* arrangements for their supply, rather from the sea* than from the common limited resources of water-companies: the head of water thus given, and led amongst the shipping, should be such as will pour *volumes*, not petty jets d'eau, as from common fire-engines, that do but aggravate the fierceness of the combustion by their insignificant streams, and embarrass all extensive arrangements by the confusion and interference of their numerous working parties with those employed in the removal of the neighbouring materials, &c.

The writer was on duty at the fire in Devonport Dockyard, in 1840: as long as the flames from the ships, their sheds, and the neighbouring piles of plank and timber,

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* Salt water freezes far less readily than fresh,—hence an additional reason for availing oneself of this resource in countries near the sea, when the cold is severe and the pipes soon frozen.

were at all inclined to advance, though driven on by only the very light wind of that morning, the engines could only retire, as it was *impossible* to face the heat: it was only when the providential change of wind (the only thing that saved the yard) sent the fire back over the ground it had imperfectly cleared, that the fire-engines could be at all satisfactorily employed. One great cause of danger, in such cases, lies in the extraordinary height and distance to which pieces of burning wood are lifted and carried by the slightest zephyr, that when untouched would require a gale to move them along the ground: when fully ignited, the volume of rarefied air around them evidently gives them the buoyancy of a fire-balloon.

In extinguishing fires in towns, an Engineer will act wisely to avoid having anything to do with them, unless on a distinct understanding with the municipal authorities that his directions are to be implicitly followed, and that the police assist in keeping the ground clear. When there is a military party co-operating, the task is far more likely to be satisfactory. The first thing to be done is to plant lines of sentries to keep off the mob, allowing no one to pass but such as are called by the police: lines of men should also be formed to the nearest pumps and wells, to pass on buckets, either to feed the engines, or be thrown on the flames. Orders being given to this effect, the Officer will, in general, save time by reconnoitring the building outside and inside, quickly, before he posts the engines, or takes other measures. Possibly some arrangements will have been made by others before he arrives, and in this case, where disturbing such may be unadvisable, even to afford a better application, it is of consequence to feel, "It is too late to do what I wish,—I will do the best with what remains to be done;" and then act with decision and energy. In making examination inside, he may often creep on hands and knees, along passages and into rooms, breathing freely, where he could not stand upright half a minute without suffocation.

There are no tools, on such occasions, like the crow-bar and felling-axe; the former for knocking holes through walls, to make short lines for passing the hoses; and both, for destroying floors, partitions, &c., especially such as are in any way connected with or composed of lath and plaster, where fire lurks in a way not easily conceived by those who have not seen it.*

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† "The intensity and consequent danger from fire is (*cæteris paribus*) as the cubic contents of the building in which the fire takes place.

"In warehouses or stores, where large quantities of combustible goods are kept, floors of brick arches, supported by cast-iron pillars and bearers, are no protection, as the heat is sufficient to fuse the cast iron, or to weaken it, so as to render it unable to bear the weight and strain of the arches. The heat also expands the iron to such an extent as to unsettle the brick-work: the wrought ties also become useless from expansion and losing their rigidity.

"These remarks do not apply to dwelling-houses, as the use of cast-iron bearers reduces the quantity of timber so much, that if there is nothing kept in the house, with the exception of the usual quantity of furniture, it is not likely that the heat will be great enough seriously to injure the cast iron, if sufficiently strong originally, which is not always the case.

"Sheet iron nailed over timber is no protection against continued heat, but only against flame for a short time.

"Several buildings have been set fire to by the use of iron hearths.

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* For notices on the use of powder in fires, see 'Demolition,'—buildings.

† From a letter with which the Committee were favoured by Mr. Braidwood (68, Watling Street), Superintendent of the London Fire-Engine Establishment.

"Wherever a wall can possibly be carried through the roof, it is the best protection against fire, even if there should be openings in the floors below. When a fire takes place, the heated air and smoke rises immediately, and fills the roof and upper floors, causing the materials to give off gas, which takes fire as soon as the fresh air is admitted below to carry up the flame.

"In extinguishing fires, the first point is, to keep the building where the fire is as much shut up as possible, till the engines, or other means to extinguish it, are ready for use, and then to get inside the building on fire: if this cannot be done, it is generally expected that the building will be destroyed, and in that case greater attention ought to be given to the adjoining premises. When an engine is sent to a fire here, the usual number of firemen is four besides the driver: these men are employed first in attaching the hose and suction, and then in directing the jet and the working of the engine: the mere manual labour is performed by the mob, who are paid at the rate of 1*s.* for the first, and 6*d.* for each succeeding hour."

EXTRACTS FROM THE "GENERAL REGULATIONS FOR THE LONDON FIRE-ENGINE ESTABLISHMENT," CONSISTING OF EIGHTEEN OF THE PRINCIPAL INSURANCE AND OTHER PUBLIC COMPANIES.

Organization.

London is divided into five districts, three on the north of the Thames, two on the south, in each of which is stationed a sufficient number of engines, under the charge of a Foreman, with Engineer and Firemen under him. The Superintendent has the command of the whole force.

The men are clothed uniformly, are distinguished by numbers, and are regularly exercised in the use of their engines: their whole time and service belongs to the Establishment.

General Memoranda.

"To execute their duties as *steadily* and *quietly* as possible; to be careful not to annoy the inhabitants of houses they may be called upon to enter; to treat all persons with civility; to take care to preserve *presence of mind and good temper;* and not to allow themselves to be distracted from their duty by the advice or directions of any persons but their own officers."

Conditions of Service.

"The age of admission of men to be, Engineers not exceeding 50, and Firemen not exceeding 40 years. Not exceeding 25, nor under 18, for men who have not previously been Firemen. Pay varies for Firemen from 21*s.* to 24*s.* 6*d.* per week; the Engineer and Foreman 28*s.* per week. Foreman of Districts 1*s.* per week extra for every engine under his charge. Uniform is found by the Establishment."

Outline of General Duty.

"One-third of the men to be on duty night and day at the different engine-houses —the whole to be liable to be called up for attendance at fires, or for any other duty." On a fire breaking out, the whole of the men of that district, ⅔rds of the collateral, and ⅓rd of the flank district, are to be in attendance; also 1 engine from collateral district, and 1 from one flank. In case of doubt as to boundary, both adjoining districts send all, and the remaining three send ⅓rd. In case of emergency the Superintendent will call in such additional force as he may require. The engines will be conveyed to fires at not less than 7 miles per hour, and the men who do not accompany the engine at not less than 5 miles per hour.

Foreman.

"He will be careful to place the engine in such a manner that the men who work at the levers may be in no danger from the falling of the premises on fire; and also that the engines may not be in the way of people carrying out furniture, &c.; but above all things he will endeavour to place the Engineers with their branch-pipes in such positions *that the water from the branches may directly strike the burning materials:* this he cannot too often inculcate on the men placed under him, as upon this point being properly attended to depends entirely the effect of the engines. To attain this most desirable end, it will be frequently necessary to enter the premises on fire; and the Foreman must take care so to place his men that they can easily escape. If he has reason to suspect that the building is not sufficiently secure, he will station one or two competent men to observe the state of the building, and to give the alarm when they see any danger. He will never allow any man unaccompanied by another to enter a building on fire. He will not throw more water on the premises than is absolutely necessary to extinguish the fire, as all that is thrown on after the fire is extinguished only tends to increase the damage.

"*When the inmates of the premises on fire are removed,* the Foreman will endeavour to exclude air from the parts on fire, by shutting all doors and windows as far as may be practicable."*

"He will be responsible for the engines in his district being each provided with the articles contained in the following list:

2 lengths of scaling ladder.
1 canvas sheet with 10 or 12 handles of rope round the edge of it.
2 pieces of 2½" rope, one 10 fathom and one 14 fathom long.
6 lengths of hose, each 40 feet long.
2 branch-pipes, one 2½, and the other 4 to 6 feet long.
1 spare nozzle to ditto.
2 lengths of suction-pipe, each about 6 feet long.
1 flat rose.
1 goose neck.
1 stand cock.
2 balls of stripes of sheep-skin.
2 balls of small cord.
2 dog-tails.
1 dam-board.
1 boat-hook.
1 mattock.
1 shovel.
1 saw.
1 screw-wrench.
1 portable cistern.
1 hatchet or pole-axe.
1 crow-bar.
Instruments for opening the fire-plugs, and keys for turning the stop-cocks of the water mains."

FIRE ANNIHILATOR.

Professor Phillips's Fire Annihilators are now patented, and are undertaken by a Company, 105, Leadenhall Street, London.

The following are excerpts from their pamphlet of 1851:

"The materials with which the chamber of the machine is charged are gypsum, charcoal, and nitre, made up into a solid body, and placed over a small reservoir of water. Into this an inverted phial is placed, containing chlorate of potash and sugar, and in a hollow globe at the nether end, a small quantity of sulphuric acid. By hitting a spike on the head this chamber is broken, and the contents being distributed

* This paragraph is printed on the cards delivered to the police: the pocket-book from whence the above memoranda are taken is given to the firemen only.

amongst the other ingredients, a vapour is created, which being turned upon the fire instantly puts it out."

"The great advantages possessed by the gas employed over water are as follows:—The gas is evolved at a temperature of about 160 degrees Fahrenheit, and comes in contact with flame having a temperature of about 3000 degrees, and under which temperature it cannot exist. The gas absorbs part of this heat, and not only in proportion to its original volume, but expands as much as a hundred times more, each part still retaining highly absorbent powers. Now, water thrown into a body of flame only acts on the part immediately in contact with it, and although it might be

Fig. 1.—Fire Annihilator for domestic use.

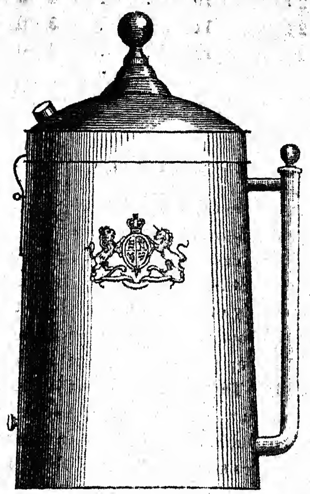
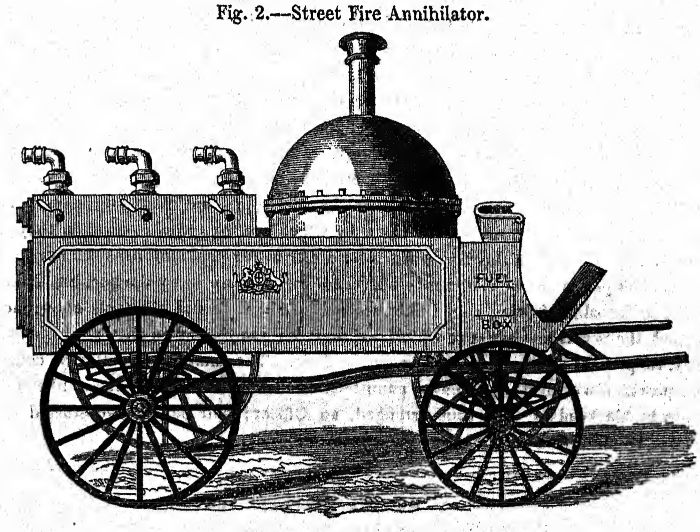


Fig. 2.—Street Fire Annihilator.



used at, say, 32 degrees Fahrenheit, much lower than the gas, yet it is found that a very small part assumes the form of vapour on coming in contact with flame, and spreads through it; the greater quantity falls down by its superior weight and is wasted."

The Prices of Machines and Charges.

	Size of Machine. Height.	Diameter.	Price, including One Charge.	Price of each Spare Charge.
	Inches.	Inches.	£. s. d.	£. s. d.
No. 1	16	8	2 2 0	0 5 0
2	18	9	3 0 0	0 7 6
3	20	10	4 0 0	0 10 0
4	22	11	5 0 0	0 12 0
5	24	12	6 0 0	0 14 0

The machines can be made to order of any size, at a proportionate price.

FIRE CART.

Notwithstanding all that system can effect, much precious time, *in first moments*, is consumed before the establishment of fire-engines in our dockyards and arsenals can be brought into play in case of fire. The following practice obtains in the Devonport Dockyard; and whether the fire has broken out in the yard or not, an invaluable assistance is promptly on the spot, before most or any of the Fire-Office engines, or those of the neighbouring barracks, are well in motion.

A large strong cart is fitted up to carry either the engine,—or else the party, with the engine dragging behind.* The best kind of cart is that which (with wheels of the usual size) is slung very low on a crooked axle, as in the description called 'ducks' at Woolwich, and 'floats' in Dublin. Two horses are always at hand, with a strong but very simple harness, besides saddle, whip, and spurs, for the driver, who goes as postilion.

Attached to the engine are as many buckets as can be conveniently hung; the hoses are coiled away on the top of the well; the branch-pipe and suction-hoses lashed to the side of the body; a double screw-box (one end fitting the town pipes and the other those of the dockyard), wrenches, hammer, spare leather washers, &c., &c., are in a small box; two or three coils of 2½-inch rope, of 50 yards each, (for fire-hooks, and letting down persons from windows,) and a coil of 50 yards of 1¼-inch line for passing hoses and stores: both sorts of rope should be well worked till rendered soft and pliable. Fixed to the sides and ends are 2 felling-axes, 2 sledge-hammers, 2 crow-bars, 2 shovels, and 2 pickaxes, as well as the drag-ropes, and extra purchases. The cart is fitted with a cross bar in front, by which the party hold on when they are carried: to the ends of this bar, sockets for a pair of carriage lanthorns are fixed. At convenient points on the sides and ends (inside and out) are hung the buckets, 2 short ladders, (capable of being joined like escalading ladders?) and the tools above mentioned, the points and edges of which last must be guarded when they are inside the cart, to prevent injuries to the party in the dark. The men, as a matter of course, are provided with leather helmets, gauntlets, and screens for their faces, like those worn by blacksmiths. As thus arranged, an Officer† and party have started well *within* 10 minutes after the alarm was given.

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* For short distances only, when thus dragged behind.

† Lieutenant Williams, R. N., by whom the above was contrived and executed.

It may be advisable to add to the above a copper-covered chest fitted with powder-bags, portfires, &c., principally for the purpose of cutting off a mass of houses irrecoverably on fire, by the rapid destruction of a line of intermediate buildings.

R. J. N.

FORAGE, BULK AND WEIGHT OF.—From measurements taken expressly for this article.

Hay in flat and tolerably square bundles, as usually delivered	$4\frac{1}{4}$ lbs. per cub. ft.
	Trusses supposed to weigh 56 lbs., but varying from 52 to 58 lbs.
Straw in flat and tolerably square bundles, though not so compact	$3\frac{1}{10}$ lbs. per cub. ft.
	Trusses supposed to weigh 38 lbs., but varying from 30 to 40 lbs.
Oats, new	3·64 cub. ft. per cwt.
Barley, do.	2·38 „ „
Wheat, kiln-dried *	2·36 „ „

Of course considerable allowance would be made, in providing space for forage, on the above quantities.

The ration of forage for Artillery and Cavalry, at home, is

Oats	10 lbs.
Hay	12 „
Straw	8 „

R. J. N.

FORDS.†

In examining and reporting upon a ford, the main points to be considered are the firmness and regularity of the bottom, its length, width, and direction, the depth (and its increase by tides or floods), the rapidity of the current, the facilities of access, security from attack, and the means of rendering it impassable: a ford should always be tried personally before making a report on its capabilities.

The *depth* of fords for cavalry should not be more than 4 feet 4 inches, and for infantry 3 feet 3 inches; but if the stream is not very rapid, and the direction of the crossing is down-stream, the latter may pass by holding on to the horses, even if the depth is 4 feet. Should the stream be very rapid, however, depths much less than these could not be considered fordable, particularly if the bottom is uneven. Carriages with wheels 5 feet in diameter may cross a ford 4 feet deep; but if it is necessary to keep their contents dry, the depth should not be more than 2, or at most $2\frac{1}{2}$ feet. Fords are generally to be found above or below a bend,‡ and often lie in lines diagonally across the river: small gravel forms the best bottom; and rock, on the contrary, the most dangerous, unless perfectly regular and not slippery. They may be sounded by means of a boat having a pole attached. But cavalry or good

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* Inserted here as matter of convenience: raw wheat is somewhat lighter.

† By Captain Bainbrigge, R. E.

‡ See Professional Papers, vol. v. p. 9, pars. 6, 7, 8.

swimmers may effect it with lances or poles, carefully feeling their way before advancing.

Parts which may be too deep, or even the whole width, if the river is narrow, may be rendered fordable by throwing in fascines parallel to the direction of the current, and loading them with stones, which must afterwards be covered with smaller material to render the surface level. The approaches should also be levelled, and where the soil is soft, rendered firm by covering them with fascines, &c., so that the troops may advance with a broad front, and rapidly mount the further bank.

The extent and direction of the ford should be clearly marked out by means of poles firmly fixed, and these may be notched, so that a dangerous rise in the river may be observed. If the current is rapid, a number of these placed along the upper edge of the ford, and connected by ropes, will also be useful to prevent men on foot being swept away; and boats and horsemen should also be in readiness to rescue them. The force of the current may be broken by the cavalry crossing a little above them; but if the bottom is sandy, the cavalry should cross after the infantry and artillery, as the passage of the former deepens a ford sometimes very materially.

The opening and shutting of the mill-sluices will sometimes alter the depth of fords, and floods may even entirely destroy them: they can be rendered impracticable by means of large stones, harrows, planks with spikes, sharp stakes driven in so as to be concealed by the water, abattis, &c., or by cutting trenches across.

POSTSCRIPT.

Memorandum of the Equipment of Field Batteries and Troops of Horse Artillery, as approved by the Master-General, 14th January, 1853.

Nature of Batteries.	Ordnance.								Ammunition Waggons.							Rounds of Ammunition per gun and howitzer.						Rounds per battery in the field.	
	12-pr. gun.	32-pr. howitzer.	9-pr. gun.	24-pr. howitzer.	6-pr. gun.	12-pr. howitzer.	Total guns.	Total howitzers.	Gun.	Howitzer.	Rocket Carriage.	Forge Waggon.	Store Waggons.	Store Cart.	Total carriages.	12-pr. gun.	32-pr. howitzer.	9-pr. gun.	24-pr. howitzer.	6-pr. gun.	12-pr. howitzer.	Gun.	Howitzer.
12-pr.	4	2					4	2	7	5		1	2	1	22	164	159					656	318
9-pr.			4	2			4	2	6	5		1	1	1	20			176	174			704	348
6-pr.					4	2	4	2	5	4	1	1	1	1	19					231	236	924	472

N. B.—The 6-pr. batteries are supposed to be attached to Horse Artillery.

10*th February*, 1853.

HUGHES, PRINTER,
KING'S HEAD COURT, GOUGH SQUARE.